

Vol. 59

1983

Nos. 1-4

THE PAN-PACIFIC ENTOMOLOGIST



In Honor of
RICHARD M. BOHART
on the Occasion of his 70th Birthday

SAN FRANCISCO, CALIFORNIA • 1983

Published by the PACIFIC COAST ENTOMOLOGICAL SOCIETY
in cooperation with THE CALIFORNIA ACADEMY OF SCIENCES

The Pan-Pacific Entomologist

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Published quarterly in January, April, July, and October with Society Proceedings appearing in the October number. All communications regarding nonreceipt of numbers, requests for sample copies, and financial communications should be addressed to the Treasurer, Dr. Wojciech J. Pulawski, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118.

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The annual dues, paid in advance, are \$15.00 for regular members of the Society, \$7.50 for student members, or \$20.00 for subscription only. Members of the Society receive *The Pan-Pacific Entomologist*. Single copies of recent numbers are \$5.00 each or \$20.00 a volume. Write to the Treasurer for prices of earlier back numbers. Make all checks payable to the *Pacific Coast Entomological Society*.

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Title of Publication: The Pan-Pacific Entomologist.

Location of Office of Publication, Business Office of Publisher and Owner: Pacific Coast Entomological Society, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118.

Editor: P. H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco 94118

Managing Editor and Known Bondholders or other Security Holders: None.

This issue mailed Sept. 28, 1983

The Pan-Pacific Entomologist (ISSN 0031-0603)

PRINTED BY THE ALLEN PRESS, INC., LAWRENCE, KANSAS 66044, U.S.A.



Published by the
Pacific Coast Entomological Society
in cooperation with
The California Academy of Sciences

VOLUME FIFTY-NINE

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IN HONOR OF

RICHARD M. BOHART

ON THE OCCASION OF HIS 70TH BIRTHDAY

Dick Bohart has been a member of the Pacific Coast Entomological Society for nearly half a century, and the Society takes great pleasure in dedicating this issue to him on his 70th birthday, September 28, 1983.



R. M. Bohart, April 1973 at Davis. Photograph by Carll Goodpasture.

PREFACE

This special issue of the Pan Pacific Entomologist had its inception about two years ago when we realized that Dick Bohart was approaching his 70th birthday. In view of his outstanding career in entomology both as scientist and teacher, it seemed appropriate to commemorate this event by dedicating an issue of the journal to him, an issue filled with papers by his students, colleagues and friends. All of us wish Dick well on his special natal anniversary and hope he will have many more productive years with his beloved wasps.

The biography that begins this issue is not the usual type that accompanies "Festschrifts." It is a multi-author concoction filled with anecdotes, plaudits, humor and history. We have invited friends and relatives to write about their remembrances of Dick; asking each one to cover a certain period in his life. A summary of his impact in the scientific community, his qualities, accomplishments, and a bibliography of Dick's publications conclude the biography.

We have had help from a number of people in putting this issue together. Dave Smith gave us insight into the world of copy editing. The following helped us with biographical and bibliographical material: Lionel Stange, George "Ned" Bohart, Roy Snelling, Frank Parker, Bob Bechtel, Patti Paige Adams, Margaret Bohart, Bob Schuster, Bob Washino, Lynn and Bob Kimsey, Norm Smith and Ev Schlinger. To all these people we extend our thanks.

Arnold S. Menke and E. Eric Grissell
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Washington, DC 20560

A Biography of an Entomologist

R. M. BOHART—A BROTHER'S PERSPECTIVE

G. E. Bohart¹

Dick's artistic talents are among my earliest recollections. I suppose he was 8 and I was 5 when I went from door to door in Washington, D.C. selling little dishes he made from clay we dug from the street in front of our house. I recall them as being handsomely decorated with clover leaf designs made from different colors of clay. He retained this interest for many years. In his high school and early college days, he made clay models of his own concepts of futuristic autos, of animals in San Francisco's Fleischacker Zoo, of my head, and of female figures discovered in magazines. The many items were made from clays we dug out of the Berkeley hills and, although they were never fired, some of them still remain in his home as *objets d'art*.

His budding scientific interests were manifested early by experiments with quick cooling of red hot clinkers taken from the furnace and dropped into the toilet. I can still see our cat with her kittens swimming around in the flooded basement that resulted from this experiment. Another endeavor involved anaesthetizing the same cat with illuminating gas. Fortunately, she survived both ordeals.

Besides his talents as a sculptor and scientific experimenter, he was a candy maker of no mean ability. On one occasion during his teen years he made a huge batch of fudge on the "QT." Suddenly, he spied mother coming home early. The pan full of fudge went onto a pile of furniture stored behind a curtain in our basement butterfly collection workshop. Since the candy was snatched off the stove too soon, it never completely hardened and, weeks later, after the pan had been accidentally jostled, mother spied a glacial tongue of fudge creeping out from behind the curtain. The furniture was kind of sticky but mighty sweet and tasty.

Dick was indeed a "man for all seasons." During his high school years, he and I used to fire a football at each other's heads at close range. This led to throwing it for distance on a course we measured out on the street. Finally, it led to his competing in the annual football team kick and throw contest. It must have been embarrassing for the team and its coaches when Dick, as a sophomore in street clothes, won the throwing event against the team's star players. His name was engraved on the silver trophy cup, but when he won the event the second year in a row, someone dropped the cup and broke it. That was the end of this contest at U.C. You can draw your own conclusions from this story.

Early on, Dick developed a keen appreciation of the female form. I believe it was in his early teens that issues of "Paris Nights" and similar magazines began turning up in various hiding places around the house. At first I was very shocked and felt sure that he was destined for hell fire and damnation. However, before very long, I, too, began to appreciate the attractions that lay between the maga-

¹ Bee Biology and Systematics Laboratory, ARS, USDA, Utah State University, UMC 53, Logan, Utah 84322.

zine's covers. His interest was not restricted to graphic representations. For example, I recall two young ladies up the block whose bedroom window faced ours. Since they sometimes failed to pull down the shade, Dick began to make some careful studies which resulted in his rather sexist nicknames for the girls, PPB, for pretty pink bottom and PBB, for pretty big bottom. I cannot affirm or discredit the accuracy of his designations since I could never get my hands on the field glasses during critical observation periods. However, his subsequently demonstrated ability to discern minute distinguishing differences between insects leads me to believe that he did not let his excitement interfere with the accuracy of his observations.

Paleontology was another of Dick's youthful interests. For example, when, as a college freshman, he got a job as caretaker of a duck hunting club on Point Reyes, he found dozens of Miocene marine fossils along a lonely stretch of beach. He brought back numerous cetacean ear bones and several skulls of a dolphin subsequently described as *Echinorhynchodelphus pontereyensis* by a professor in the Paleontology Department. A monstrous whale skull imbedded in the beach had to remain there. Rowing back to the clubhouse with his trophies, he spotted some pine cones protruding from a sea cliff. Dr. Mason, the paleobotanist at U.C., was very excited with this find since it helped him develop a revised concept of pine speciation and distribution in coastal California during the Pleistocene.

"Rock hounding" was a hobby we both carried on with our father who was a research chemist, but more significantly to him, a frustrated would-be mineralogist. In 1926 we drove our old Hupmobile through Oregon and Washington collecting agates from every gravel service station driveway encountered. We also scoured such favorite rock hound haunts as Agate Beach and the Medford lava beds where plenty of "good stuff" could still be found. In later years, when Dad put together a lapidary outfit, Dick, with his ready eye for symmetry, gave the initial shape to most of our "gems." I smoothed out the little ridges and flats, and Dad, whose eyesight was not the best, did the polishing. I still have some polished stones that Dick found in such far away places as our junior high school playground in Berkeley and the dry bed of Putah Creek near Davis.

I should say something about Dick's early experiences in entomology. Although I claim to be the first of us to start collecting butterflies (at age 7), he soon "took over" as big brother. We developed a great proficiency at picking "silverspots" and swallowtails from butterfly bushes (*Buddleia*) with our hands without damaging the scale patterns. After moving to California, Dick vowed that we would collect every kind of butterfly in the State. We had to sell a number of rare "aberrations" to a wealthy amateur lepidopterist named Gunder before we could finance trips to southern California to collect such rarities as the Sonora Blue and the Pima Orangetip.

Dick's final transition from butterfly collecting to a more scientific endeavor took place while he was making an insect collection to satisfy requirements for the U.C. field course in Entomology. He found a bee (*Andrena*) with an odd triangular plate protruding from its abdomen. He pulled out a sack-like parasite that soon produced a state of confusion in the Entomology Department. Dr. W. B. Herms sent Dick to the Zoology Department where Dr. Sol F. Light pronounced that it was not a helminth. Professor E. O. Essig recognized it as an insect and suggested showing it to Dr. E. C. VanDyke, a noted coleopterist. He recognized

it at once as a female *Stylops* (order Strepsiptera) and excited Dick's interest in the group to the point that he continued studying Strepsiptera and eventually made them the subject of his Ph.D. thesis.

R. M. BOHART—A WIFE'S PERSPECTIVE

Margaret E. Russell Bohart²

I have been asked to make a few comments about our early life together. I am stunned to realize we have been going together fifty-one years. We've kept so busy I guess we haven't noticed the passing of time.

Dick and I met at Cal-Berkeley the fall of 1932, and I was soon following him across the Berkeley hills and Antioch sand dunes as he pursued his interest of the moment, butterflies and Strepsiptera. I have to admit that I was rather embarrassed to be seen with this big guy swinging a butterfly net, but I outgrew that, and in the end I have drawn my own snickers from young boys, as I, that gray-haired lady under a pink flowered hat, swept up the wasps in an Argentine wash.

We were married Jan. 4, 1939 and settled in West Los Angeles where Dick was teaching and doing research at UCLA. For me the fun came from the collecting trips, and I was lucky enough to go on almost all of them. From Los Angeles we had weekend camping trips to the Mojave and Borrego deserts, and sometimes longer ones to the High Sierra, and the Grand Canyon of Arizona. After a couple of years I tried my hand at collecting, as there was a limit to how much needlework I could do. I missed a lot of "bugs" in those days, and I never learned to pinch the thorax. I have my own technique.

One of Dick's research projects at UCLA was the sod webworm that was destroying lawns. At one point we went out every night, all night, every hour on the hour, to a private lawn to lie prone on the grass and, with the glow of a flashlight, watch the worms snip off tender shoots and haul them back into their homes. We also poured a solution on one square foot of sod, and then counted the worms that rose to the surface. Great way to catch a cold.

In the early spring of 1942 our Los Angeles apartment burned. While it was being redecorated we took a trip to Yosemite. We hauled his papers and typewriter along. I'm the typist. One evening we were walking across a little bridge and a mosquito got in Dick's way. He examined it and then dashed it down, saying that was one thing he was never going to work on. Fate interfered.

November 1942 Dick was drafted into the Army, but with some agile footwork he got himself into the Navy as an Ensign, and by Dec. 5 we were at the Marine base, Camp LeJeune, Jacksonville, North Carolina. He was to teach malaria and mosquito control. A few months later he was transferred to Camp Perry, Williamsburg, Virginia to do the same. Two thousand in a class, a new class every five weeks. That's where he got that voice heard a mile away. We didn't have a car so our collecting trips were small walks through the lovely woods. Of course

² 230 Shepherd's Lane, Davis, California 95616.

chiggers, sudden rain storms and humidity were something we had never had to reckon with before. We enjoyed Williamsburg and all its history.

In the early spring of 1944, Dick was transferred to Washington, DC and assigned to Naval Medical Research Unit #2 housed at the National Academy of Sciences. Almost immediately he and his brother, Ned, and Ken Knight were sent to Orlando and Tallahassee, Florida, where Dick studied mosquitoes under Dr. Boyd. We stayed a month and then returned to Washington. Thus mosquito taxonomy began in earnest and Dick was in his element. We spent our free time at the Mellon Art Gallery and the Smithsonian. Couldn't ask for anything more. At this point he tried to make a taxonomist out of me, studying the bee genus *Nomadopsis*, but it didn't take. Ned, Ken Knight, Alan Stone, Karl Krombein and other taxonomists were in DC as well as some of Dick's cousins, so we enjoyed the stay very much.

It was time to go overseas and in the fall of 1944 Dick was assigned to Guam and then Okinawa, for malaria control, and I returned home to Fullerton, Calif. Dick took with him all the equipment and photocopies of the literature necessary to carry on the study of mosquitoes in those islands. Stan Bailey was working with him, and they had good luck in cleaning up the mosquito problems of Guam.

They moved on to Okinawa a little too soon. The Marines hadn't quite finished taking it from the Japanese and Dick landed amid some shelling. His seabag came up missing and he figured it was tossed overboard, because the outline of his pistol was visible, and someone wanted the gun worse than he did. He lost all of his equipment, literature and clothes, but fortunately nothing more serious occurred. Despite occasional pot shots from the Japanese, who were still holed up in the hills, he seemed to really enjoy Okinawa, its beautiful beaches, fine swimming, and of course the insect collecting. Funny things happened, too. One of the responsibilities was to eliminate mosquito larvae by covering any standing water with xylene or a similar chemical. This assignment included outhouses. Yep, someone dropped a lighted match and blew the place up, but luckily only his dignity was bruised.

Dick could have been released from the Navy in the fall of 1945, but he agreed to stay on a few more months to get his research written up, thus we returned to Washington. We worked at the Academy every night. I did lots of typing of literature, as Dick was collecting material for other projects. Photocopying was still somebody's dream. Somewhere in these years Dick wrote the "Mosquitoes of the Philippines" (published in 1945), from specimens sent from the field.

The project came to an end, and Dick was released from the Navy in the spring of 1946 with the rank of Lt. Commander. We returned to California where his position at the University of California was waiting for him. He transferred from the UCLA campus to the Davis campus, arriving there July 1946.

A new branch of life started that came to involve many students, particularly graduate students with whom we came to have a close, personal contact. With retirement I think we miss this the most. The research and the trips to the Hawaiian and other Pacific Islands, Japan, British Isles, Western Europe, East Africa, Natal, South Africa, Argentina, Brazil, Costa Rica, Venezuela, Mexico, Australia, Canada and the United States, especially the beloved southwest, were a part of these years, too. And the gleam in the eye for another trip has not disappeared.

Just so the modern girls won't think I had no life of my own, I will tell them



Richard and Margaret Bohart at their home in Davis, July 1975. Photograph by Woj Pulawski.

I was a social worker, and had [and still has—edit.] an all absorbing hobby, genealogy. We also entertained a great deal, played a lot of bridge, and raised Pepe Le Moko, Annabel and Miss Bo, who would not like being left out. Those three kittens were with us a total of thirty-one years.

I think the greatest thing has been that Dick was lucky enough to find an occupation in this life that he has thoroughly enjoyed.

SOME REMEMBRANCES OF THE EARLY U.C. DAVIS DAYS, 1946–1956³

Ev Schlinger⁴

Although I didn't know it, when I arrived at U.C. Davis in February 1946 as a 17-year-old budding entomologist, I arrived a full four months before my future major professor, Assistant Professor Richard M. Bohart. This was a time, near the end of World War II, when U.C. Davis had about 100 students, only one of whom was a woman. Needless to say, she was well escorted!

³ Thanks go to Bob Bechtel for supplying some of the memories recorded here.

⁴ Department of Entomology, University of California, Berkeley, California 94720.

The first "post-war" Introduction to Entomology class (Ent. 1), a 5-unit semester course, was to be taught in the spring of 1946 by Drs. W. Harry Lange, Jr., and the late E. M. Stafford. There was a total of seven students in the class with two of us majoring in Entomology and two professors to teach us. What a student-teacher ratio.

In the spring of 1947, as I remember it, when "Doc" was asked to teach this Ent. 1 course, he asked several of us "older" students to go along on a field trip to the Sierras with his class to help collect insects to start to build an insect teaching collection. I clearly remember that day when he warned all of us not to drink the clear mountain water as it might be unsafe. It was a hot day, no large animals were evident, and we just had one quick drink of the cool mountain water—only to come down with dysentery the next day. I have never told Doc about the dysentery, but I learned to take his words more seriously and eventually became one of his first graduate students.

When I entered graduate school in the fall of 1950, there were six graduate students, all of whom were under the late Dr. Stan F. Bailey, head of the department. I well remember how Dr. Bailey insisted that each of us come to see him at a specified time each Saturday morning to discuss our research with him. He wouldn't discuss research with us during the week, and needless to say, we would much rather have been allowed to go collecting, or . . . Bailey insisted on being responsible for all taxonomy grad students, but about six months after I entered grad school Doc was permitted to have his first students. That was when R. C. "Bob" Bechtel, A. D. "Biff" Telford, and I chose to work with him. In those days, the graduate students had offices in the "quonset" building next to the Entomology building. This was an army surplus, metal, pre-fab structure, which, although freezing in the winter, kept us and our insects dry.

At that time, Doc was working on at least three separate projects; i.e., (1) Taxonomy of Culicidae, (2) Taxonomy of Vespidae, and (3) the California Cherry Tree's insects and their control. He was also very much involved with working up and collecting sphecid wasps. He took the three of us in stride even though all of us had chosen thesis topics quite different than his; i.e., Bechtel had chosen to work on Plastoceridae, Telford had chosen to study diapause phenomena in marsh mosquitoes, and I had chosen the biology of spiders and their parasitoids. Doc tried hard to turn Bechtel and me into "Hymenopterists," and by allowing us to help prepare and publish papers with him (Bechtel on California social Vespidae and myself on California *Oxybelus* wasps), he taught us considerable about taxonomic methodologies and Hymenoptera. Bechtel went on to study the family Sapygidae, Telford eventually took on the chrysidid genus *Parnopes*, but I finally settled on a taxonomic revision of the Acroceridae (Diptera). Jack Hall and Bob Washino eventually joined Doc's group as master's candidates working on bombyliid flies and mosquitoes, respectively.

The years 1950-1956 were exciting times for us, and other than hard day-to-day laboratory revisionary work and field sampling, I think the events I remember most were the special field collecting trips. Locally, in those days, Putah Creek was close by and contained between its banks some most interesting insects. Doc was able to join these trips frequently and even more often in the higher Putah Canyon area, especially around Monticello near Pope Valley, with Samuel Spring the favorite site. This latter locality, now covered by waters of the government's

massive project called Lake Berryessa, became the type locality of a number of his new species.

Other events remembered well were Doc and his competitive spirit on our Departmental Softball Team which, by the way, we won most of the time, and our "horseshoe" games after work just outside his office in the "old" one-story Entomology building. Badminton was also one of Doc's favorite pastimes and he was instrumental in the establishment of the "Davis Badminton Club," of which he became president.

Those were wonderful years for all of us, and I am pleased to have been lucky enough to have had the guidance and tutorship of one great guy and excellent entomology professor, Dick Bohart.

MEMORIES OF "DOC"—1956 TO 1967

Arnold S. Menke⁵

My first exposure to "Doc" was on the entomology summer field course, Ent. 49, in 1956 at Tanbark Flat in the San Gabriel Mountains of southern California. It was the second time he had been in charge, having first led the course in 1954. Margaret accompanied him as did Bob Bechtel, the latter serving as his assistant. Some of the students who took the course that summer were Lionel Stange, Mel Sparks, Jerry Stage, Louie Shainberg, "Hal" Moffitt, Dick Bushing, "Hank" Michalk, Art Bartels, and Beverly Bartosh. I remember well the noxious rhagionid biting flies at Tanbark Flat which made collecting around camp miserable at times. Breakfast for Doc always seemed to be "Special K" and lunches often were the infamous peanut butter and jam sandwiches. I recall that Doc had a large disdain for milk claiming that it was only for kids. He used to tell us that it made adults prone to colds and other problems. Instead Doc drank Pepsi or buttermilk, the last being something of a contradiction. We could never understand how he could drink that stuff.

Doc impressed all of us as a tireless collector, and he always put in a full day of collecting. By his example and instruction we learned the many special techniques necessary to collect various kinds of insects. He was always stressing that we should not just collect big showy beetles, wasps and butterflies, and he expected everyone to catch small insects that required point mounting. During the evening while we were pinning up our material, he would come around to see what we had caught, and I recall his frequent question: "where are all the small Diptera?" Doc alerted us to the tiny sphecids and other wasps that were found on the ground and which required the "clap" technique to capture. He also drew our attention to the wondrous nannofauna that frequented mat *Euphorbia* and other prostrate plants that most of us would otherwise have ignored completely as potential sources for insects. In his own way he was always stressing observation. I remem-

⁵ Systematic Entomology Laboratory, IIBIII, ARS, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

ber when he broke off a plant stem that had blooming dodder entwined around it, showed it to some students, and asked if they knew what kind of plant it was. Of course he was hoping to trick them into thinking that the dodder was part of the plant stem, but at the same time he was pointing out that there was always more to things than met the eye at first glance. He also took the opportunity to emphasize that dodder blossoms attracted some interesting insects. Doc always seemed to be able to collect more of anything than anyone else. I remember catching a couple of rhipiphorids on an *Eriogonum* plant, the first of these beetles I had ever seen alive. Naturally I took my prizes over to Doc to show them off. To my chagrin and amazement he produced a vial containing a dozen or more rhipiphorids, telling me with a rather straight face that "they were revolving slowly in a mass on a single *Eriogonum* blossom." That was his sly style of humour.

Lionel Stange, my pseudo-brother and collecting chum, possessed an old 1947 Studebaker which he and I used during the course for weekend forays to collect insects at distant favorite collecting haunts like Blythe on the Colorado River. I think that Doc secretly enjoyed our initiative, but I know that we also caused him some concern and problems. We always brought back stuff that no one else in the class had seen and that engendered some jealousy among fellow students. Also Lionel's car was approaching a basket case. In fact it did die one night when Lionel and I were driving down to Glendora. On a hairpin turn on that long winding mountain road the right front axle snapped bringing us to a grinding halt short of the dropoff. Doc was not too happy when we arrived back at Tanbark Flat late that night courtesy of the Glendora police.

Doc had some very definite ideas about how insects should be mounted and labeled. He always used #2 pins, and we marveled at his disdain for point punches. He would cut his points from strips of paper with scissors. Doc insisted that insect labels not exceed 12 mm in length, nor be more than 5 printed lines. During the course Lionel Stange and I ran the label printing press instead of washing dishes.

My next encounter with Doc was at his invitation. In the Spring of 1957 when I was finishing up my senior year at Berkeley and contemplating grad school, he wrote to me asking if I would be interested in being his Research Assistant at Davis to help him with teaching general entomology and systematic entomology. To quote from his letter, "each of these jobs . . . [offers] . . . the finest possible experience for an entomologist." I had visited the Davis campus several times and liked the country atmosphere and small student body (about 2000) far better than the Berkeley fog and zoo, so I jumped at the opportunity. Thus Doc acquired a water bug (belostomatid) lover. When I arrived at Davis in September, 1957, he had just become Department Chairman.

Helping Doc with the labs in these courses proved to be a great experience, and looking back on those days now, I realize that in the taxonomic course, especially, he accomplished something that is missed in many such courses: he taught people practical, everyday, taxonomic procedure, the real world of nomenclature and how you deal with it, how descriptions and keys are written, how illustrations are rendered, and how you put it all together in a publishable paper. Truly a rare experience for those fortunate to have taken his taxonomy course. As he admitted in his letter to me, "we run 112 [taxonomy] somewhat differently from Berkeley. The student takes a special problem under close supervision of the lab instructor and staff member." Each student actually did a miniature (some not so small!)

research problem starting with a box of insects, usually representing a genus in a family of Hymenoptera. The specimens had to be sorted to species and identified (or declared to be new which was not infrequent), described, illustrated, a key to them constructed, and the whole thing written up as a publishable paper.

Some students did in fact make valuable contributions and discoveries in Ent. 112 which they subsequently published, or which later blossomed into thesis problems. For example, Paul Marsh discovered a new species of the sphecoid genus *Prionyx* which Doc later described and published as *subatratus*. Frank Parker discovered excellent mouthpart characters that easily separated the very similar females of two species of *Prionyx*. Frank subsequently published his findings which essentially made Doc's own recent paper on the genus obsolete. The chrysidid genus *Omalus* was revised by Doc and Luciano Campos subsequent to the latter's discoveries while working on the genus in Ent. 112. As for myself, lab instructor, I became enamored with the sphecoid genus *Ammophila* which Dick James was working with in the course. He discovered a new species which I eventually described as *formicoides*, and I eventually revised the genus for my Ph.D. thesis.

Doc's exam questions in taxonomy were famous. They always included at least one thorny nomenclatorial question to solve, and he often had a number of obscure terms to define, some of which bordered on craziness (hypodigm, cheironym, natio, for example). Some of his questions were so subjective and broad in scope that they were a bear to grade.

General Entomology lab involved identification of insect orders and common families, and included a number of afternoon and weekend collecting trips. An identified collection of a considerable number of orders and families was a prerequisite to passing. Doc always took a shine to the ever present girls in his classes, and I recall that he tended to be lenient toward them at grading time.

In 1959 I was Doc's assistant on Ent. 49 which was held at the University of California's Santa Barbara campus located at Goleta. Doc also brought along Paul Marsh who was "selected" to run the label printing press. Possibly this was the most popular summer field course ever because of the nearby beaches to which most of us fled in the afternoons. Sunbathing, body surfing, and swimming made for great tans, but we discovered early on why they drill for oil offshore. Removing tar from feet after a trip to the beach became routine. We lived in a fraternity house, the only time most of us, especially the women, had such an experience. The men's john was a single large room with a number of unenclosed toilets along one wall. Nothing like communal elimination. Among the students taking the course were Frank Parker, Gene Cherry, Patti Paige, Meredith Bruck, Wally Steffan, Jim and Jack Bath, Ray Spore, Craig Campbell, and Bob Granados. Collecting near the beaches was generally very good for wasps such as *Ammophila*, and Doc discovered an *Oxybelus* nesting site adjacent to a lagoon behind the beach. He assigned the task of watching *Oxybelus* nesting behavior to Paul Marsh. I well remember how Paul spent many days sitting in the hot sun watching the wasps' activities while the rest of us hit the beaches for aquatic sports. Paul's observations were subsequently published in collaboration with Doc and that was Paul's first paper. One day Doc borrowed my VW beetle for a collecting trip. Reports I got from those that accompanied him suggested that I was lucky that the gear box was still intact after he returned.

Frank Parker and the girls had an interesting experience one night. There had

been a "private party" in the girls' room. After the other participants had gone back to their respective sleeping quarters, a student, who shall remain nameless, returned to the girls' room around 2 AM thoroughly inebriated. The girls asked him to leave and he subsequently fell down the stairs suffering a large, deep gash on his forehead in the process. He was bleeding profusely and Patti sought Frank Parker's help. She found his room in the dark and woke him up. They got him into Frank's car, and Frank and the two girls drove to the campus infirmary. The nurse on duty called the police after seeing the student's condition. By chance the police were looking for two guys and two women who had been causing some disturbance in town. They took everyone to the police station for questioning. Somehow Meredith and Patti, dressed in nightgowns, eventually convinced the police to release them. They were taken back to the fraternity house in the wee hours of the morning just in time to pretend to be getting up in preparation for that day's scheduled field trip. When Doc saw the fellow that morning with all his stitches he was naturally concerned. Doc was told that the student "ran into something in the dark" and that the wound was not serious. As far as I know, Doc never knew the true story of that wild night.

The late 50's and early 60's saw Doc's graduate student load mushrooming. Paul Marsh was working on braconids, Helen Court was working on crabronine sphecids, Frank Parker was working on astatine sphecids, Byron Chaniotis and Fred Iltis were working on mosquitoes, Chet Moore was working on chrysidids, Lionel Stange was working on ant lions, and I was doing a master's thesis on a genus of Belostomatidae. Obviously Doc didn't insist that his students take on thesis problems in the area of his first love, the predatory wasps.

Another aspect of his graduate student guidance that is noteworthy was the rather limited amount of it. He tended to let his students pursue their thesis work without much inspection of progress, etc., at least after initial discussions of procedure. This meant that a student without strong inner drive (someone other than a "born taxonomist") would probably not survive long. This aspect of Doc's tutelage developed independence, discipline, and self initiative. The last is perhaps exemplified by the fact that his students often published papers on various taxonomic projects "on the side" during their graduate tenure. They were able to do this in part because Doc only expected his Research Assistants to teach laboratory in his courses. Rarely did he ask his RA to do anything else. Thus the rest of your time was free for other pursuits.

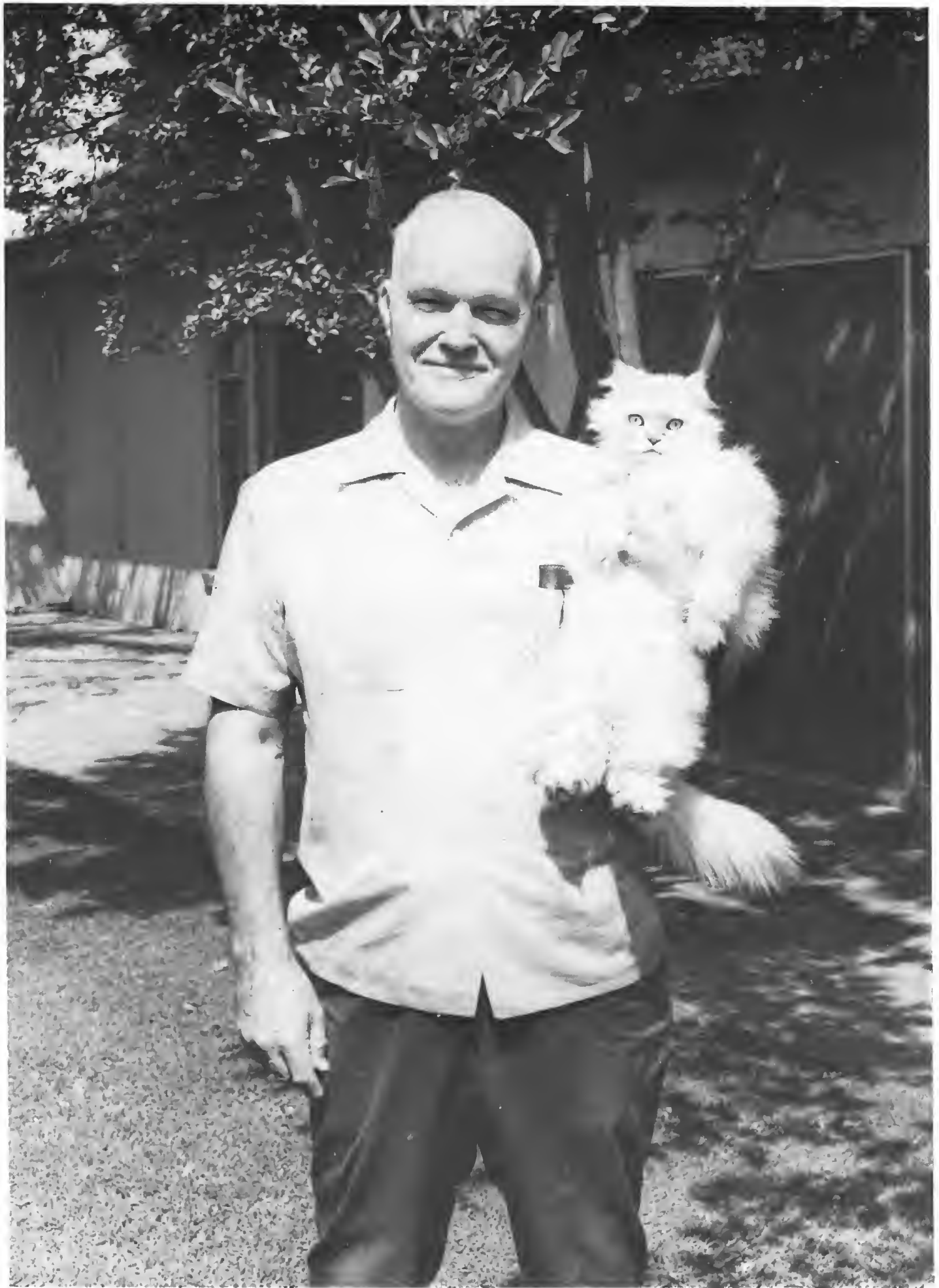
Doc commonly took on one of his students as junior author on some taxonomic research problem. In my case I first worked with him on the sphecid genus *Palmodes*, one of the spinoffs of Ent. 112. What an experience! (and not unique to me): while looking at specimens under the microscope he verbally described the creature, and I wrote it down to produce the description. That is not to imply that I did not do some looking at material myself. In fact, in this and all subsequent projects on which he and I collaborated, I was always impressed by the fact that he would listen to and often agree with my ideas and viewpoints on various matters. No one could accuse him of being dogmatic, stubborn maybe, but not inflexible. An example of his continued growth as a scientist was his change in attitude on subspecies. He was from the school that made every geographic color form a different subspecies, but in later years he came to appreciate the clinal nature common to many of these forms and his formal naming of them steadily

decreased. This change in philosophy was influenced in part by his students which emphasizes his willingness to listen to new ideas. His de-emphasis of subgenera in favor of species groups in later years is another example that comes to mind.

The research for and writing of the book "Sphecoid Wasps of the World" by Dick and me occupied a big chunk of both our lives—nearly 10 years in fact. Perhaps it is appropriate here to review a little of its history. While I was finishing up my Ph.D. thesis on *Ammophila* in 1965, Doc suggested that he and I collaborate on a revision of the North American genera of Sphecidae for which he would seek NSF support. Naturally his proposal appealed to me. After some thought I suggested that from the standpoint of producing a viable classification it probably would be better to expand our horizons. He agreed, and at first we set our sights on a generic study of the Sphecidae of the New World. In the initial stages of our NSF supported study we soon realized that only a worldwide revision would produce a sound classification for the family, and that became our ultimate goal. Our game plan was to divide the work between us, each having responsibility for researching and writing up a number of the subfamilies. Of course we had help from Doc's students, past and present (Frank Parker, Dick Brumley, Lionel Stange, Helen Court, Eric Grissell, among others), and colleagues (Wojciech Pulawski and Jack van der Vecht in particular), but the main input was ours. Dividing up the work between us may have resulted in some unevenness in treatment but it was the only logical way to handle the immense job before us.

Initially Dick assumed that we could finish the project in about three years, but expansion to a world study made this an impossibility. I don't think either of us (or anyone else that has tackled such a project) had any idea of the millstone we were putting around our necks, nor the time it was going to take to remove it. I worked on the project at Davis for three years until the NSF grant expired, at which time I was forced to find employment elsewhere, namely with the Systematic Entomology Laboratory in Washington, DC. My added responsibilities slowed me down some, but Dick plowed forward with his usual determinedness. I suspect that with my departure he probably worried some about keeping the whole project going at a steady pace, especially with my propensity for getting sidetracked on details. As I wrote up various sections I would forward rough drafts to Dick and he would have them typed up. We kept in touch mostly by frequent telephone calls, and fortunately I was able to visit Davis each year for periods of two to four weeks. During these visits he and I accomplished a tremendous amount of work. On one such trip we jointly worked up the Ampulicinae, and on another we did most of the introductory chapters for the book. He made one trip to Washington which gave us another opportunity to work together on the book.

By the spring of 1972 most of the taxonomic sections of the book were finished, and in May of that year we showed parts of it to the editors of the University of California Press which we hoped would publish it. They gave us tentative acceptance and we set Sept. 1 as a deadline for ourselves to complete the whole book. Dick was the instructor on Ent. 109 (formerly Ent. 49) that summer at Sagehen Creek and he spent much of his time during the course going over completed sections checking for consistency, errors, and making improvements rather than collecting. He was otherwise kept plenty busy the rest of the summer finalizing the subfamily Crabroninae, the last unfinished taxonomic section of the book. He was also saddled with the job of arranging all the plates of figures and making



Dick and Princess Silver Bow at the Bohart residence, Davis, April 29, 1973. Manuscript for the Big Blue Book had just been completed! Photograph by Arnold Menke.

sure that figure numbers were entered in the ms. correctly—a horrendous task. I busied myself with rendering drawings for my subfamily sections, checking species checklists in the Crabroninae and Nyssoninae, writing up the catalog of generic

names and their synonyms, solving last minute nomenclatorial problems that required ICZN petitions, surveying last minute morphological discoveries subfamily by subfamily, and other odd jobs. Sept. 1 came and went, and by the end of 1972 the book remained unfinished. A shortage of secretarial help at Davis was partly responsible and this caused Dick to rent a typewriter and hire a typist with personal funds in early 1973 in order to get the monster finished. We finally got the completed manuscript to the Press around May 1, 1973. Publication was then only three years away! Ahead were months of proof reading by Dick and Margaret at his end, and by Karen and me 3000 miles away. Generally Karen and I read the proofs first and then forwarded them to Dick for his turn at them. Karen Menke also did the horrendous job of typing up all of the more than 14,000 3×5 cards for the taxonomic index, one name to a card. Dick took care of general indexing, also a chore. All galleys had been proofed by mid 1974, and page proofs were received in April 1975, reviewed and returned promptly. Later, while Dick and Margaret were touring Africa in the fall of 1975 (those lucky dogs!) I had the pleasure of reading and correcting the page proofs of the index! At last the millstone was gone, and our baby arrived between blue covers on April 27, 1976. It has since become known in sphecidological circles as the Big Blue Book or simply B 3.

The years spent working with Dick, first as a student and later as a colleague, provide me with many happy memories. Dick is a remarkable guy and I especially treasure the friendship that we share.

R. M. BOHART: RECOLLECTIONS 1964–1973

E. E. Grissell⁶

My association with Dick Bohart began in the summer of 1964. As a soon-to-be undergraduate at Davis, I had an invitation to visit the entomology department and to "get acquainted." Dick fortunately happened to be chairman at the time, and he gave me both a warm welcome and a personal tour of the facilities. This was my first exposure to one of Dick's superior qualities . . . his love and enthusiasm for insects of all kinds. It is all pervasive, and he has retained this attitude for the 20 years I have known him. I'm certain it has been strongly felt by students and colleagues alike from the earliest days of his career.

My second meeting with Dick occurred only a few months later when school began. In retrospect the meeting was not quite as bad as it seemed at the time, but it was slightly different than I expected. The enthusiasm was still there to be certain, but Dick didn't seem to remember who I was . . . he couldn't remember my name. This bruised a rather young and fragile ego, but I soon learned a very simple fact about Dick . . . he can't remember anyone's name! For many years I

⁶ Systematic Entomology Laboratory, IIBIII, ARS, USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

have suspected that the first thing he does in the morning, upon arising, is to memorize the name on his driver's license so he might get at least one name correct during the day. It has been secretly amusing, over the years, to see how Dick manages to avoid the problem of introductions when the situation arises. Most of his colleagues are understanding sorts, though, and they often begin a conversation with their own name just to avoid possible confusion.

I was extremely fortunate, as a financially depauperate undergraduate, to receive Dick's early help in the form of a work-study position. Whether this opportunity was decreed by destiny, divinity, or deviousness I know not. I only know that help always came at the right time during my association with Dick and that the experience of working for him was an education, not a job. In looking back, even as a beginning student, my experiences with Dick have always been of a mutually beneficial nature: each person gaining in some way from the association. Doc has had this arrangement with many students, and most of us have recognized the benefits we've received. The fact is, that many of us have been dragged (albeit screaming and kicking) through our first publication largely on Dick's coat tails. We simply learned by doing. Perhaps more importantly though, some of us have learned the lesson exemplified by such generosity of time, knowledge, and experience. In matters of research and publication, Doc always gave credit where it was due, and usually gave a little extra for good measure.

During the mid 60's and early 70's, Dick had a profusion of graduate students working on taxonomic projects: Steve Buckett was working on noctuids, Mike Gardner on millipeds, Charles Dailey on cynipids, Don Horning on chrysidids, and I worked on chalcidoids. An "adopted" student, Dug Miller, worked on mealybugs. Doc even had several students, David Levin, Dick Brumley, Edmundo Rubio, and Joanne Slansky Wasbauer, who actually worked on sphecids. It is to Dick's credit that he gave each student the freedom to choose his or her own project. He was equally as willing to suggest any number of potential projects as well. Doc gave us the opportunity to work at our own pace which encouraged a necessary amount of self-reliance and responsibility. Conversely, however, Doc's door was always open and he would stop his own work at a moment's notice to answer questions or give help if he could. Occasionally there would be a flurry of pointed questions about "progress," intended, I'm certain, to gently prod some of the slower members of his entourage. Dick took an interest in each of his students and tried to accommodate the individual idiosyncrasies which characterize most taxonomists.

For several years (1968-1971) I worked as Dick's research and teaching assistant. This, again, was an education not only in taxonomy, but also in human behavior. Under his guidance I learned to catalog, collect and identify Hymenoptera, organize data, and write papers. At least I hope I learned. I also learned how to translate what Dick "said" into what he actually "wanted." This was purely a matter of survival. In the beginning it was my reaction to immediately do something if Dick asked me to. I soon learned, however, from his previous assistant, to put off until tomorrow whatever today's request might be. That way Dick might have a few days to sort of "rearrange" his thoughts, as it were. And it seemed as if he were constantly rearranging, much to the irritation of his taxonomy students. Now that Dick is safely retired I can reveal the secret "code" by which we assistants all lived. Doc was known to have his way of doing things,

and there seemed, to the uninitiated, to be a rather stubborn streak to his nature. Those of us who lived by the code, however, knew that if Doc were “hit-up” with a new idea during his “rearranging phase,” it often became incorporated into his thoughts and could be prodded forth several days later as a worthwhile revelation. It was *his* idea, of course, but that was actually a fair price to pay for getting things done *our* way. Graduate students aren’t entirely stupid, you know!

The term paper in the undergraduate taxonomy course was a good example of this phenomenon. It was universally acknowledged, even before a student took the course, that the paper was an evil of unspeakable vileness. Some of us actually enjoyed the paper, but most did not. As an assistant in the course for 3 years, I was the intermediary between students and professor. This position was not the least bit enviable, and the first year was, shall we say, a struggle (“It was hell,” said a former assistant). While students at Berkeley were burning the library and protesting every social evil, students in the taxonomy class at Davis were revolting (to say the least) against writing descriptions and making distribution maps. Needless to say, the assistant took the majority of the heat. By the second year, however, by invoking “the code,” we managed to persuade Doc to alter the method of presenting the term paper. This so unbalanced the students that before they could organize themselves to riot, the course was over. Whereupon Doc and I, to illustrate one of our finer attributes, immediately took off for the deserts to do some collecting. The ploy worked so well that we tried it again the third year, and as far as I know, Doc changed the paper every year thereafter. I was fortunate to learn the universal doctrine of teaching under Doc’s supervision: always leave the students off-balance, it is best for everyone involved!

My fondest experiences with Dick are associated with the five-week summer field course (then Ent. 49) and our numerous collecting trips together. In Ent. 49 Dick charged up a frenzy of entomomania among the undergraduates. This was due in large part to genuine enthusiasm and a prodigious knowledge of insects. Mention of this has been made in the previous paper by Arnold Menke, and I can confirm the effects. Students were out day and night ravaging the countryside for just “one more family.” One summer, we had a particularly knowledgeable group of students, several of whom specialized in various micro-faunas. The number of families in each student’s collection grew dramatically as battles raged over where to find the smallest Diptera, Coleoptera, Lepidoptera, or Hymenoptera. I can’t remember who had the biggest collection, but I do know who held the record for “most countryside terrorized by a single entomologist”: Baldomero Villegas! With two sweep nets going at once, bandoliers of cyanide vials over each shoulder, and a gallon killing bottle under each arm, Baldo struck fear even in the heart of Dick. Doc was forced to restrain the “great destroyer” while the other students collected first. Then he would let Baldo loose, and there would be little reason to return to that particular collecting site for several years. I know that Dick secretly admired such enthusiasm in a student.

Shortly before I first took Ent. 49 in 1966, Dick had changed the course from solely making an insect collection to including an ecological or biological project. The project was designed to “encourage” students to look at living insects. Almost anything would do, and if we didn’t have an idea, Doc would soon supply us with one. Doc suggested that another student (Steve Clement) and I conduct observations on the nesting habits of a little known wasp named *Euparagia scutellaris*.

These observations formed the basis for my first publication (in coauthorship with Clement). When asked if Dick would also like to be a coauthor, he characteristically declined on the pretext that he had had nothing to do with the paper. Unlike many professors, Doc didn't take credit for work he didn't do.

A few years after taking the course, I had the privilege (at least it seemed so at the time) of serving as the teaching assistant. I might say that having the responsibility for 14 students is not quite the same as being one of the students. Having survived three years as intermediary between Doc and students in the taxonomy course had helped a bit, but I was not quite prepared for the food strikes, pranks, and physical exhaustion which came with the summer students. Doc always took it in stride, and in spite of suffering from a severe vitamin deficiency, could outcollect and outlast any of us any day. However I always managed to outdo Dick in one respect: it had something to do with automobiles. As I vaguely recall, a single trip with Doc at the wheel taught one a certain respect for one's life. Whenever a trip was in the offing, 14 (of 14) students tried jamming themselves into my station wagon. I still have heel marks in the back of my head to prove it.

Entomology 49 was a rewarding entomological and social experience for many students . . . a chance to "live, breathe, and eat bugs" as Doc would say. It was undoubtedly the most concentrated dose of real-world entomology that a student could receive.

Field trips with Doc were a special experience, shall we say, especially as they required a one to one relationship. They also required a lot of driving, but I try not to think much about that. Doc introduced me to the California desert regions, early on. He took me on numerous trips to what appeared to be the most barren places imaginable. I soon came to appreciate Doc's ability to find insects in these spots, however, and I must confess that the deserts are still my favorite domain. At first it was Doc who had all the expertise in terms of how and where to collect, but after a few years I think I showed him a thing or two about chalcidoids. With a little practice, however, Doc was as proficient as I was, and he was again the master collector. This, I think, is one of Dick's secrets . . . he is always willing to learn new things about bugs. Collecting trips provided a chance for protracted conversations, discussions of taxonomy, progress reports on the dissertation, comparisons of collecting techniques, assorted braggings about the day's catch, and keeping up with departmental gossip. These trips were a superior educational experience not to be duplicated in any classroom. Over the years, Dick has supplemented many a student's classroom education with his numerous field trips.

Over the years, I've grown to appreciate Dick more and more as an entomologist in the finest sense of the word. There is probably no aspect of entomology which, if required, he could not master. He has worked upon a diversity of taxonomic groups and in a diversity of fields from toxicology and economic entomology to ethology, ecology, and taxonomy. I've also grown to realize that Doc always had the interests of his students at heart, and in this respect something must additionally be said about his wife of 45 years, Margaret. In the treatment of students it is somewhat difficult to know where Doc leaves off and Margaret begins. In many ways Margaret has been the unofficial overseer of student concerns, and I know she has contributed much to their welfare. How many of us have enjoyed the hospitality of the Bohart home over the years, both as students and long afterwards? I was especially touched by the kindness of Dick and Margaret who

took me into their home for the last year of my graduate work. Such attitudes toward students are the rule with Margaret and Dick and that makes them the special people they are.

THE LAST GRAD-STUDENT YEARS, 1973–1983

Lynn Kimsey⁷

I first became acquainted with “Doc” Bohart as an undergraduate in his Insect Systematics class in 1973. By this time in his career he had earned a reputation as a tough instructor and because of this the students in systematics, both graduate and undergraduate, were terrified of him. Many GI’s from Viet Nam were beginning to come through the entomology program in this period; several told me that even in the Army they had heard that Dr. R. M. Bohart ate undergraduates for breakfast. Despite the students’ fears of Doc in systematics class, many of them went into systematics or fields of research requiring this kind of background because of his influence. Most students came away with an understanding of systematics, species distinctions, and interspecies variation that they could have gotten nowhere else.

After completing his systematics class I decided I would never go into Systematics as a field of study, and certainly never work on wasps. However, one year later Doc proved to be quite persuasive; we co-authored a revision of the sphecoid genus *Mellinus*, and I began my career as a wasp systematist. I worked as a scientific illustrator for Doc for about 6 years, drawing everything from mosquito larvae to eumenid legs and sphecoid genitalia. He was a demanding taskmaster, each drawing had to be accurately and neatly done. The quality of the illustrations I make today is largely due to his training.

In 1975 I entered graduate school and became his student in systematics. Although my thesis work was on orchid bees we began a series of cooperative papers on the Chrysididae with the nebulous goal of straightening out the family. The first was the marathon revision of the Western Hemisphere *Hedychridium*. Since I was only being paid as a research assistant for 6 months he decided that we had to complete this revision of 30+, mostly new species, during this period. We lived and breathed *Hedychridium* for 6 months. That year I also was teaching assistant for his summer field course at Sage Hen Creek. Every hour not spent collecting (looking for specimens of *Hedychridium*) at Sagehen was spent looking at, writing about or drawing these wasps. Even now neither of us can look at *Hedychridium* without flinching.

While I was a graduate student the number of systematics students began to dwindle, primarily due to a growing lack of interest, even antagonism, toward systematics in the scientific community. Baldo Villegas, Norm Smith, Joanne Slansky (in absentia) and I were Doc’s graduate students in 1975. In 1978 Joanne

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completed her thesis, Baldo took a job with the California Department of Agriculture, and Doc took on his last graduate student, Larry French, who is still under his guidance. In January, 1979, Doc retired from the University of California and became Professor Emeritus. Norm Smith and I finished our theses in 1980 and 1979, respectively.

The years I've known Doc have been years of change for him. Although considered stubborn by many, he is one of the most open-minded scientists about his field of study I have ever met. For example, Doc, in spite of years of disdain for certain new taxonomic approaches, finally adopted the use of cladograms in his papers to demonstrate relationships between genera and higher categories. In a lesser vein he now even uses a point punch to make points for mounting small specimens. [This is one change that is difficult to believe! Editors.] As Doc neared retirement he became more easy going and relaxed, and his students gradually lost their fear of him although the awe remained. In short, he became a pussycat.

Some things never seem to change, however. Even at the last Sage Hen class he taught (1979), his attitudes toward milk, buttermilk, peanut butter and jam sandwiches, Special K, and EXTRA dry martinis (double, of course) remained unchanged. The same could be said for his infamous Sunday dinner at Sage Hen—wine punch, concocted of lemon-lime soda and \$2 a gallon red wine. This tradition continued despite surreptitious additions of absolute ethanol to the punch by a variety of students.

Since retiring, Doc still comes in to work practically every day or works at home on Chrysididae and Sphecidae. We're still pursuing the nebulous goal of revising the family Chrysididae and have continued to do cooperative papers on this group.

R. M. BOHART'S IMPACT ON THE U.C. DAVIS INSECT COLLECTION

R. O. Schuster⁸

In 1946 the Entomology Department made a commitment to establish a research collection by hiring A. T. McClay to curate what had been mainly a teaching oriented collection. Mr. McClay brought to the department a fine personal collection of Coleoptera, and Dick contributed research material in the Diptera, Hymenoptera, and Strepsiptera. Dick's interests eventually polarized with the aculeate wasps, and the collection has grown in this area to be among the most comprehensive in the world.

In 1950 Dick became involved with Entomology 49 (now 109), a summer field course stressing the biology, collecting techniques, and taxonomy of insects. Later, he taught the course for both the U.C. Berkeley and Davis campuses. He provided financial assistance for the development of the University Sage Hen Creek Field

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Station near Truckee, California, and for many years the Entomology 109 course has been conducted exclusively from Sage Hen. The insect fauna of the Sage Hen area is extremely well known as a result of repeated and intensive collecting, and the specimens collected by Dick, along with those of numerous students, are deposited in the department's collection. Throughout the years, specimens collected by Dick's undergraduate and graduate students have contributed significantly to the development of the collection at Davis.

Field work in support of his research took him frequently, usually with co-workers or students, to desert areas of the western United States. Expeditions to Africa and South America were made in 1972 and 1975–1976, Venezuela in 1973, and Australia in 1979. Margaret Bohart has been a frequent collecting companion on these trips, and is a proficient collector. The resulting specimens have been carefully taken, meticulously prepared, and of exceptional scientific value.

In addition to the specimens that have directly or indirectly resulted from Dick's research and teaching, he also has provided generous personal financial support which has assisted in the collection's becoming a major resource for systematic entomology.

R. M. BOHART—AN OVERVIEW

E. E. Grissell and A. S. Menke

During the past two years we have had occasion to contact many former students, colleagues, and friends of Dick Bohart. Through hours of conversations, acres of correspondence, and pounds of manuscripts, we have come to learn that there is an unsuspected uniformity of opinion about Dick among his associates. We believe it is appropriate to present a short overview of the consensus which has crystalized as we have put this "Festschrift" together.

One of the main points of agreement among Dick's associates has been his generosity toward students, friends, and colleagues. On the strictly practical side this generosity has been expressed in the form of untold thousands of identifications which Dick has given over many years to nearly anyone who has asked for them. More than one curator has told us that they slip "extra" specimens into a shipment which Dick has requested and that these additional specimens always come back identified. The material is always identified in a quick, conscientious manner whether it is a group he is currently working upon, or a group of some past interest. The names are provided, in many cases, at the loss of personal research time as well as a great amount of labor which often extends late into the night at home. It is a labor of love, of course, and its breadth of coverage will likely not be seen again in this day of specialization. He is among the last of those "all knowledgeable" entomologists who can identify countless species in a wide range of families.

Perhaps more important than the obvious public service that Dick has provided over the past 50 years is the generosity of time which he has extended to students.

Dick has always been available for questions, even at the expense of his own work. Not only did he give us the feeling that our work was important (little did we know!), but he exemplified what all of us should represent as taxonomists. Perhaps Norm Smith, one of Dick's later students, summed it up best when he wrote to us:

"I think one thing that I respected most about Doc was that he was an excellent example of what a University Professor should be. A young, impressionable Ph.D. student could find no finer example to emulate. In academia, Doc practiced what he preached and was able to set himself as a prime example of what could be accomplished with dedication and perseverance in one's field of endeavor."

Doc's generosity to students has taken a variety of forms, from subsidizing field trips at personal expense to helping with employment. But many students remember him most as the motivating force behind their first publication. Many of us have been junior authors with Dick, and it is safe to say, we think, that we may not always have contributed our "fair" share toward the paper. On the other hand, where other professors might insist on being a co-author on a student's dissertation, Dick would never consider it.

In co-authoring a paper, Dick was a considerable taskmaster, but at the same time he was willing to listen to the other person's point of view and to compromise. Dick also read and reviewed a student's paper with care and concern for the future of that student. Roy Snelling wrote the following about the help that Dick gave him as an early student:

"Always, he was remarkably patient and helpful to me, answering my naive questions, identifying specimens, sending reprints, etc. He also had the no doubt painful task of reading my first paper on *Polistes* systematics (I was then a junior in high school). With admirable restraint and kindness, Dick suggested I might profit from holding the paper a while until I had accumulated more data on certain of the forms; the paper has long since disappeared into gracious oblivion."

Dick is continuing his work, of course, with projects on Sphecidae and Chrysididae, but he is no longer taking graduate students. However, Dick's former students indirectly continue his work and have achieved some notoriety of their own. Among these may be included the Chief of the USDA's Systematic Entomology Laboratory and 3 Research Entomologists with the same organization; the Chief of the USDA's Bee Biology and Systematics Laboratory, Logan, Utah; the Supervisory Research Entomologist of the Division of Vector-Borne Viral Diseases, Ft. Collins, Colorado; the former Dean of the College of Agriculture, Universidad de Zulia, Maricaibo, Venezuela; the former chairman of the Department of Entomology, University of California, Riverside; professors and assistant professors in various universities throughout the country, and several entomologists in state agricultural departments.

Everyone we've contacted has commented upon Dick's remarkably broad interest in insects . . . an interest that has spanned more than 60 years. Although recognized largely for his work with numerous groups of aculeate Hymenoptera, Dick has also published papers on Thysanoptera, Lepidoptera, Diptera, Homop-

tera, Strepsiptera, and even Isopoda! His work has ranged from the toxicological to the taxonomical. A glimpse through the appended bibliography will quickly attest to Dick's diversity as an entomologist. One notes several books or book length treatises in several different groups of insects. Over the years his knowledge and scientific stature in taxonomy have prompted many authors to name new species and genera in his honor. He even has a family, Bohartillidae Kinzelbach (Strepsiptera), named after him.

Perhaps less well known is the role that Dick has played in building the University of California insect collection at Davis. This collection was in a fledgling state in the late 40's, and Dick, along with the help of A. T. McClay, its first curator, and R. O. Schuster, its present curator, played a leading role in building and developing the collection, often subsidizing its growth with personal funds. Dick has always been a keen collector and a meticulous curator, and material placed in the collection is of the highest quality. Today, the insect museum at Davis is one of the outstanding university collections in the country.

As an aside from Dick's career, few who have come into contact with him have failed to note his rather acute sense of humor. A personal anecdote, concerning long-known or "old-time" taxonomists, is a special pleasure coming from Dick. We have also all fallen victim to the unexpected pun which could erupt at any time or place. Better than trying to explain all of this we have been very fortunate in obtaining a series of photos taken by Bob Kimsey during one of Dick's taxonomy classes in 1979. We think that Bob has done a remarkable job of capturing his expressions and moods which most of us remember as students. The accompanying captions are doubly amusing when one considers that Dick wrote them himself. Little did he know these photos would ever be made public, but how very well he knows what his students are thinking!

We think anyone who knows Dick will agree that over his long and varied career one of his finest assets has been Margaret, his wife. In fact we suspect that many of Dick's finer qualities have been encouraged and nurtured by Margaret. Perhaps she has added just the right touch of "reason" to balance out Dick's somewhat over-zealous nature. Not to detract from Dick, but we can attest to rather severe working conditions upon occasion; conditions which were mercifully interrupted by coffee and cake, or a freshly baked pie upon the insistence of Margaret. While Dick watched over our minds, Margaret often took care of our nutritional needs and made certain Dick didn't treat us too severely. She also offered Dick's friends, colleagues, students, and visitors the hospitality of her home. We suspect that by taking exceptionally good care of Dick over these many years, that Margaret has contributed more than her fair share to Dick's accomplishments. We know that she is a very capable collector in her own right. We also know that Margaret was the precursor of the photocopying machine and that for many years she "duplicated" all of Dick's necessary research references on a typewriter. Such duty goes a bit beyond normal marital laws, we feel. Perhaps less well known is Margaret's role as a guide during many of Dick's collecting trips. It is a well kept secret that Dick cannot tell left from right, especially while driving. Margaret has been, on many occasions, the only means by which Dick has been able to return home with any certainty. We all recognize that Dick would not be the person he is without Margaret.

Of all that has been said of Dick Bohart, perhaps the simplest and most obvious

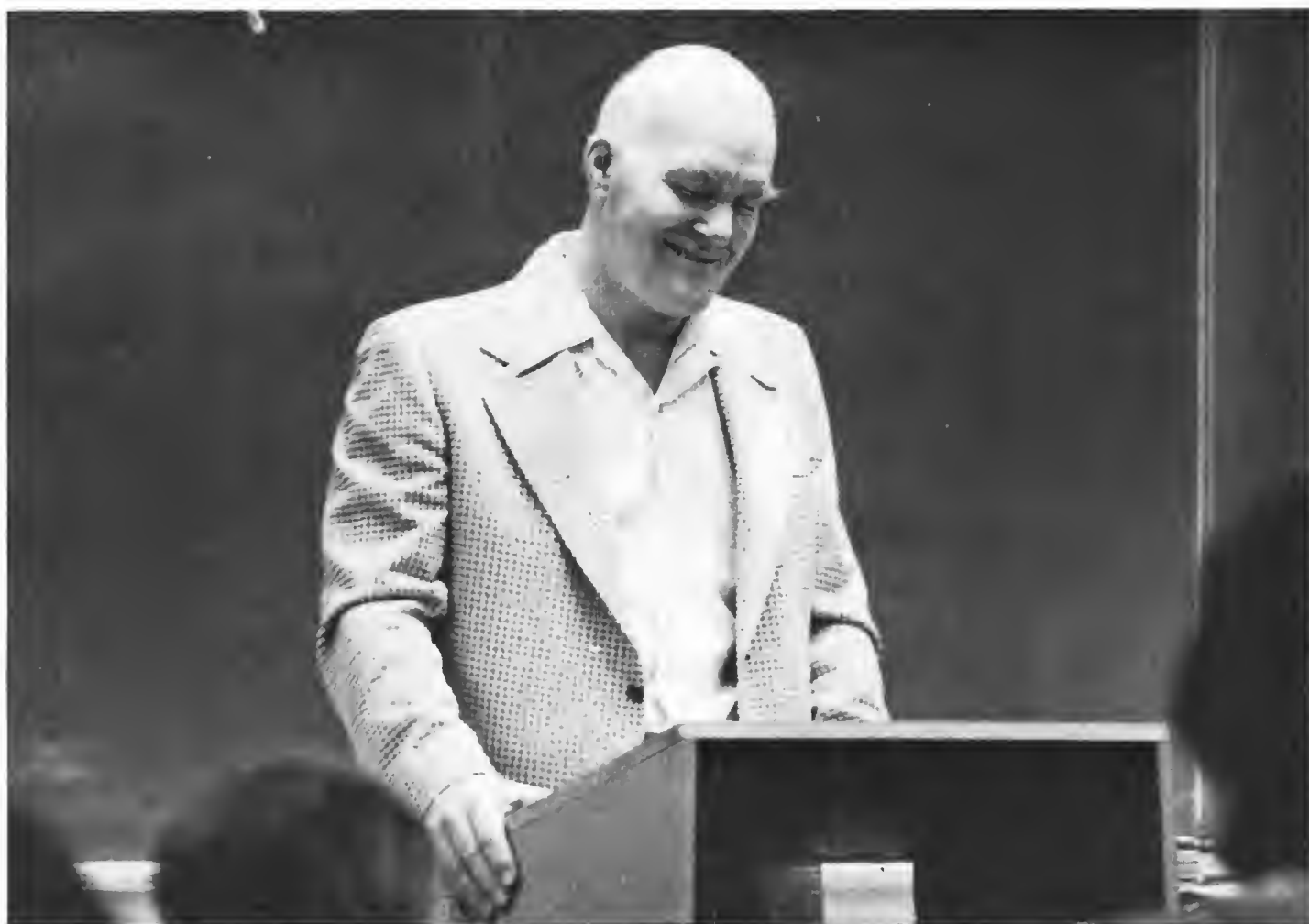
“THERE IS LITTLE BIT OF HAM IN EVERY PROFESSOR—SOME MORE THAN OTHERS”



“You may as well resign yourselves, we are both stuck here for an hour”



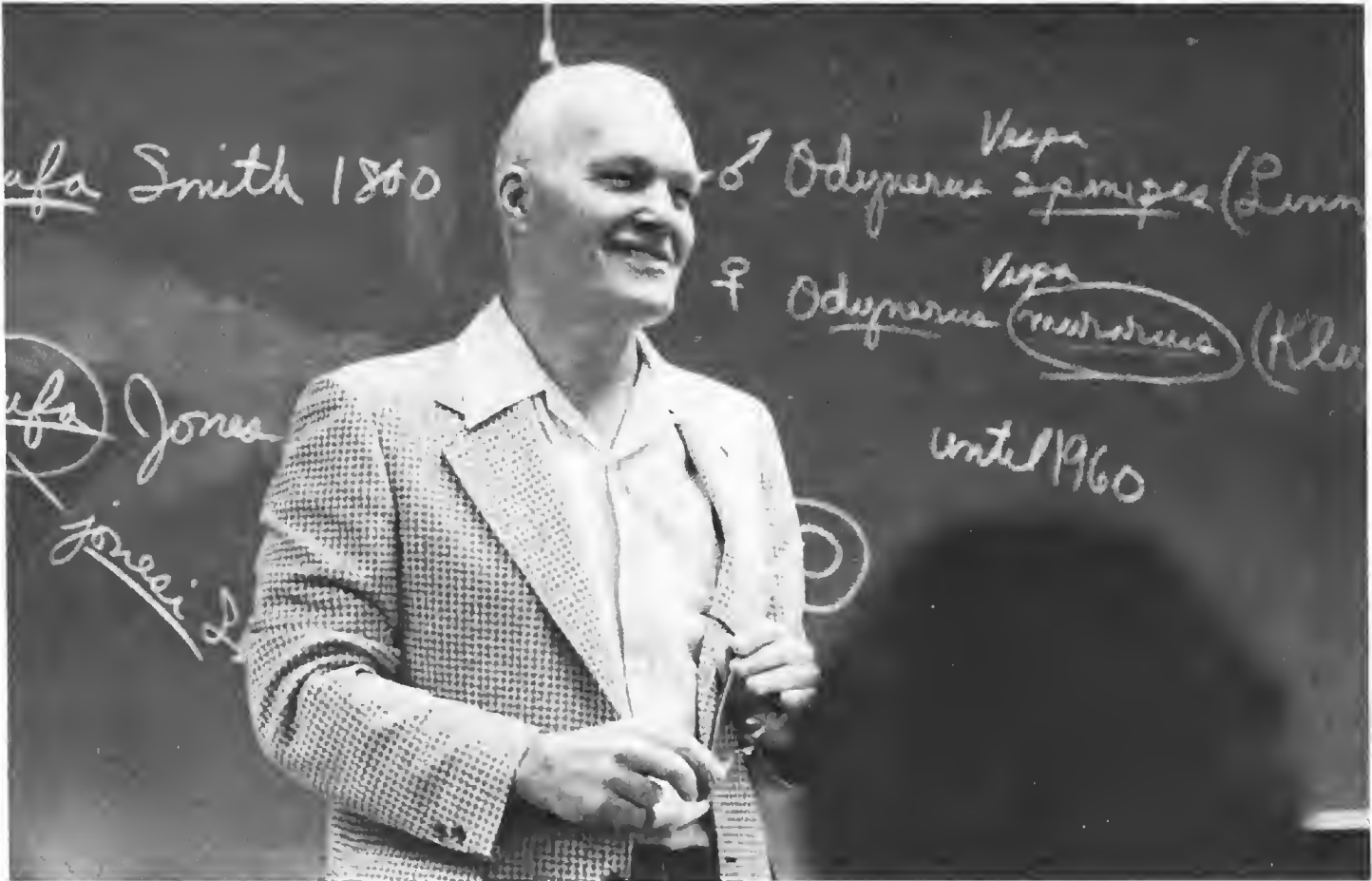
“Pay close attention, or else!”



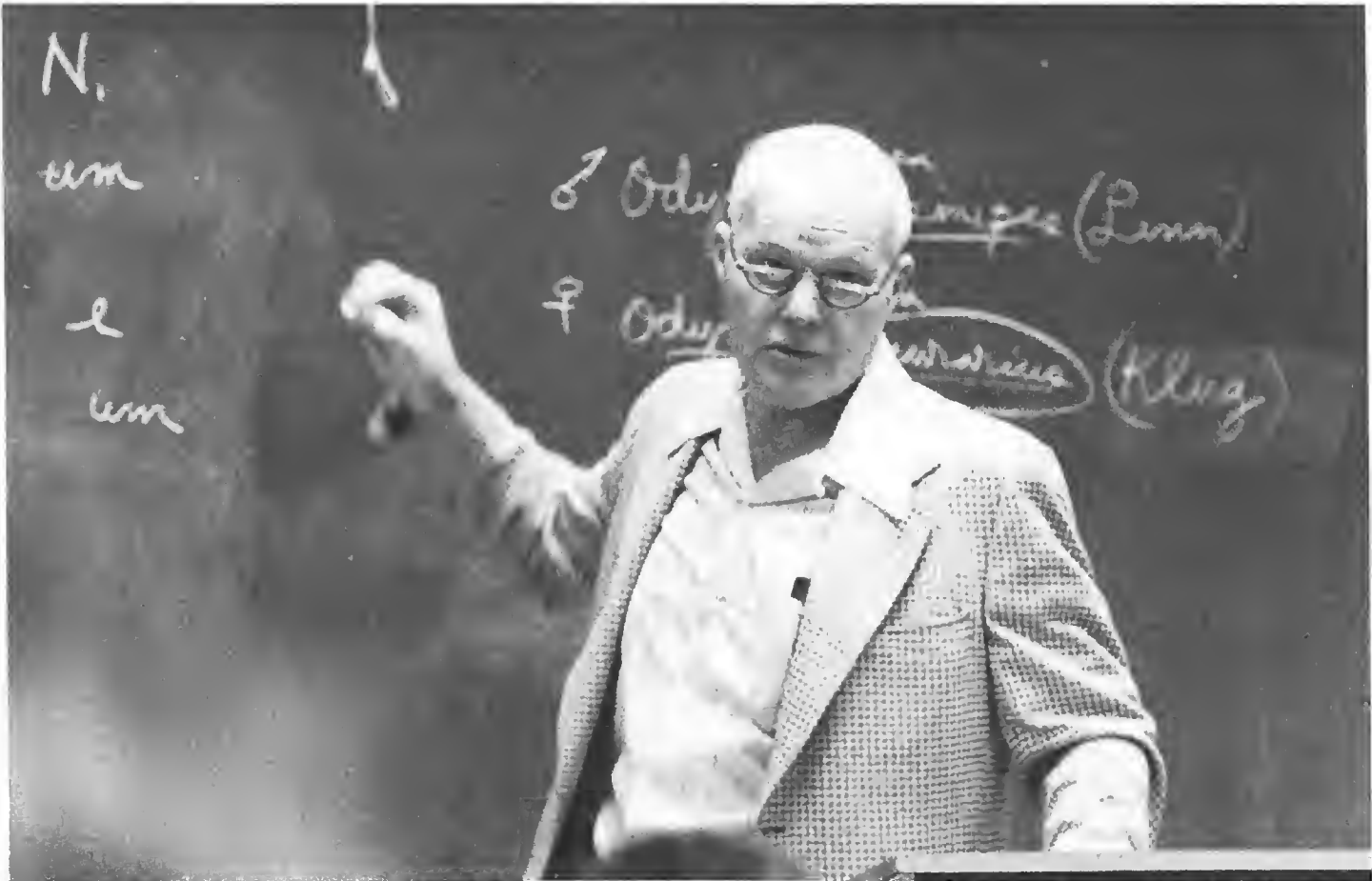
Look out! He's coming up with something!



"This is really gruesome stuff"



“You can’t believe what those old systematists did!”



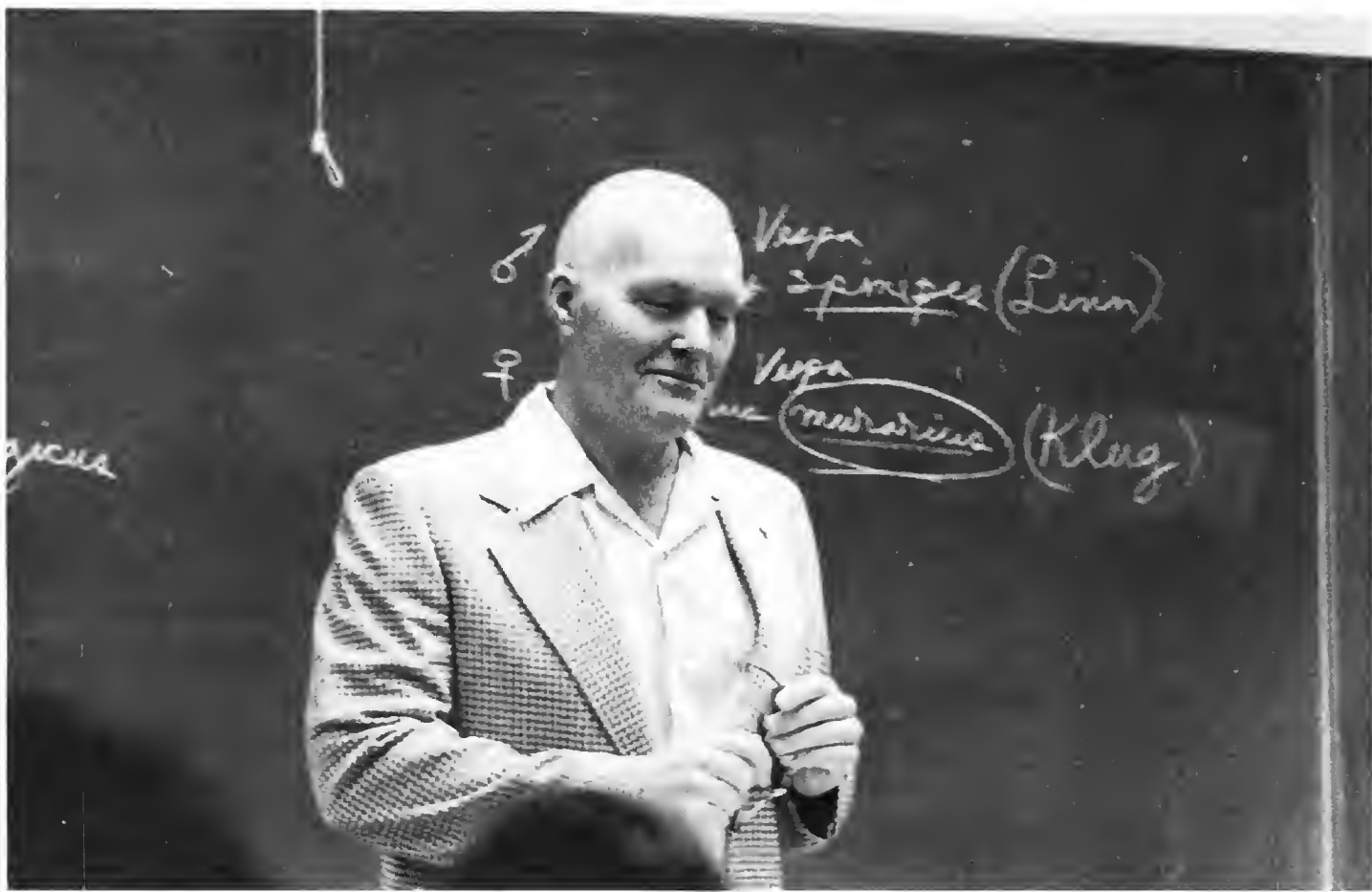
“I am absolutely serious about this!”



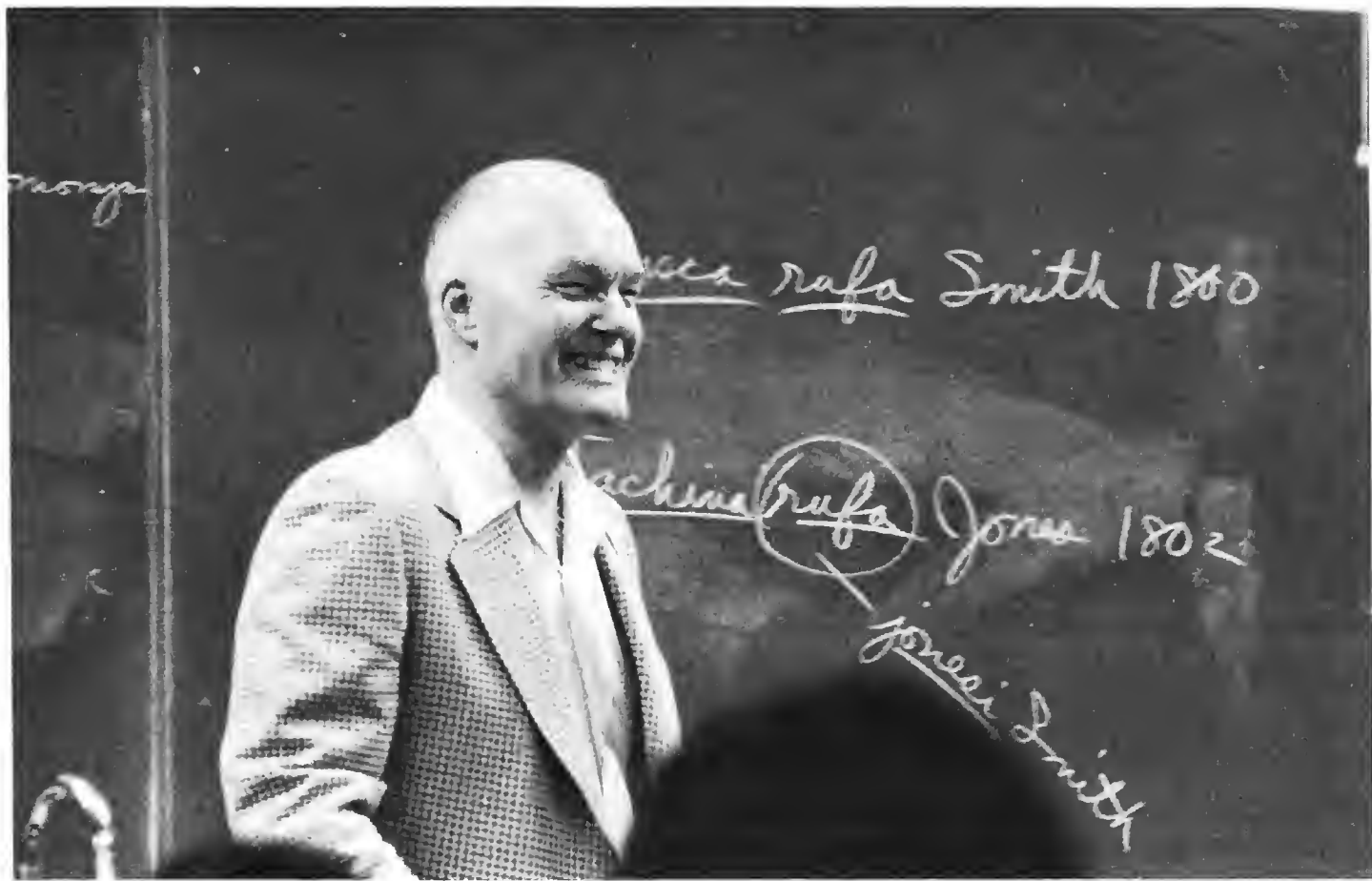
“This nomenclature stuff takes close concentration”



“My opinion of numerical taxonomy is hard to express in words”



"I have a little story to tell you"



"I enjoyed the punch line too!"

conclusion is that he has an overwhelming and truly enthusiastic love of insects. There is a realization among his friends that over the years, Dick's enthusiasm for insects, if anything, has grown stronger. We also know that this enthusiasm has infected each of his students and colleagues in some manner and that we are all the better for it. Not that many of us will duplicate Dick's remarkably broad knowledge, nor his zest for life . . . for that is not taught. It is simply admired and respected.

BIBLIOGRAPHY OF R. M. BOHART

The following list of papers by R. M. Bohart is complete through 1982. In an effort to give correct citations, including mailing dates, we personally examined nearly all of his publications. Some of his more obscure mosquito papers published during WW II were found in the Medical Entomology Project at the U.S. National Museum. Other papers were checked in the National Agriculture Library and the library of the Smithsonian Institution. Lynn Kimsey checked a few obscure papers for us, and also provided us with a copy of Dick's list of publications. Papers not seen by us are preceded by an asterisk. When known, the true date of publication, that is, the mailing date, is cited at the end of each entry. Often this has meant some sleuthing in journals. If a precise date could not be determined we have simply indicated the month of issue in quotation marks at the end of the entry. Circumstantial evidence suggests that some of Dick's papers published in the December issues of the *Journal of Economic Entomology* may not have appeared until early the following year.

We found several papers that Dick had overlooked when his list was made up. Also, some papers were out of chronological sequence in his list. The result is that the number we assign each paper in the following bibliography does not necessarily coincide with those stamped on his reprints.

1936

1. A preliminary study of the genus *Stylops* in Calif. (Part I) (Strepsiptera, Stylopidae). Pan-Pac. Ent. 12:9-18. March 20.

1937

2. A preliminary study of the genus *Stylops* in Calif. (Part II) (Strepsiptera, Stylopidae). Pan-Pac. Ent. 13:49-57. "April."
3. A new genus and species of Strepsiptera from Canada. Pan-Pac. Ent. 13: 101-105. "July."
4. Synonymy of the genus *Pseudoxenos* Saunders (Strepsiptera, Xenidae) and records of stylopized Hymenoptera from North Carolina. Psyche 44:132-137. "December."

1938

5. A synopsis of the genus *Euparagia* (Hymenoptera, Vespidae, Euparagiinae). Pan-Pac. Ent. 14:136-139. August 19.
- *6. Flower thrips in southern California on ornamentals. Floral West 4:4.

1939

7. Taxonomy of the typical subgenus *Odynerus* in North America (Hymenoptera: Vespidae [sic]). Pan-Pac. Ent. 15:76-84. April 27.
8. Notes on *Odynerus* with a key to the North American subgenera and description of a new subgenus (Hymenoptera, Vespidae). Pan-Pac. Ent. 15: 97-104. August 9.
9. A synopsis of the *Odynerus boscii* group in North America (Hymenoptera, Vespidae). Bull. Brooklyn Ent. Soc. 34:245-251. November 13.
10. A new host plant and locality record for the Christmas berry thrips. J. Econ. Ent. 32:880-881. "December."

1940

11. A revision of the North American species of *Pterocheilus* and notes on related genera (Hymenoptera, Vespidae). Ann. Ent. Soc. Amer. 33:162-208. "March."
12. A preliminary study of the subgenus *Leptochilus* in North America (Hymenoptera: Vespidae). Pan-Pac. Ent. 16:81-91. May 23.
13. Additional notes on *Pterocheilus diversicolor* Rohwer (Hymenoptera: Vespidae). Ann. Ent. Soc. Amer. 33:282. "June."
14. Studies on the biology and control of sod webworms in California. J. Econ. Ent. 33:886-890. "December."

1941

15. Yellowjackets versus campers. Pan-Pac. Ent. 17:58. May 15.
16. A revision of the Strepsiptera with special reference to the species of North America. Univ. Calif. Publ. Ent. 7:91-160. August 27.

1942

17. Life history of *Diaspis boisduvalii* and its control on *Cattleya* with calcium cyanide. J. Econ. Ent. 35:365-368. "June."
18. *Platynota stultana* as a pest of field-grown carnations. J. Econ. Ent. 35:399-403. "June."
19. R. M. Bohart and A. Mallis. The control of pillbugs and sowbugs. J. Econ. Ent. 35:654-658. "October."
20. An analysis of the *Odynerus congressus* group of the subgenus *Leptochilus* (Hymenoptera, Vespidae). Pan-Pac. Ent. 18:145-154. October 31.

1943

21. North American *Stenodynerus* of the *anormis* group (Vespidae: Hymenoptera). Bull. Brooklyn Ent. Soc. 38:6-11. March 31.
22. A new generic name in Strepsiptera and description of a new species (Strepsiptera, Stylopidae). Bull. Brooklyn Ent. Soc. 38:12-13. March 31.
23. Calcium cyanide fumigation for the western thrips. J. Econ. Ent. 36:442-444. "June."
24. New species of *Halictophagus* with a key to the genus in North America (Strepsiptera, Halictophagidae). Ann. Ent. Soc. Amer. 36:341-359. October 4.
25. Bohart, G. E., P. C. Ting, R. M. Bohart, and C. K. Dorsey. Fundamentals

of field malariology and mosquito control—A reference and teaching syllabus. U.S. Naval Construction Training Center, Medical Dept., Camp Peary [sic], Williamsburg, Va., 37 pp.

1944

26. *Stenodynerus fundatus* and related species in North America (Hymenoptera, Vespidae). Pan-Pac. Ent. 20:69–75. April 29.
27. K. L. Knight, R. M. Bohart, and G. E. Bohart. Keys to the mosquitoes of the Australasian Region. Natl. Research Council, Div. Med. Sci., Off. Med. Inform., Washington, D.C., 71 pp. "July."
28. R. M. Bohart and D. S. Farner. New culicine mosquitoes from the Philippine Islands (Diptera, Culicidae). Proc. Biol. Soc. Wash. 57:69–73. October 31.
29. A. Stone and R. M. Bohart. Studies on mosquitoes from the Philippine Islands and Australasia (Diptera: Culicidae). Proc. Ent. Soc. Wash. 46:205–225. November 21.
30. D. S. Farner and R. M. Bohart. Three new species of Australasian *Aedes*. Proc. Biol. Soc. Wash. 57:117–122. November 30.

1945

31. D. S. Farner and R. M. Bohart. A preliminary revision of the *Scutellaris* group of the genus *Aedes*. U.S. Nav. Med. Bull. 44:37–53. "January."
32. A synopsis of the Philippine mosquitoes. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 580:1–88. January.
33. A preliminary synopsis of the mosquitoes of Okinawa. U.S. Naval Med. Res. Unit #2, Med. Sect. IsCom, Okinawa, 16 pp.
- *34. Notes of disease-bearing mosquitoes in four specific areas: (a) Formosa; (b) China coast from Amoy to Shanghai; (c) Ryukyu Islands (d) Bonin Islands. Malaria and Epidemic Disease Control Bulletin #3, pp. 2–4.
35. New species and subspecies of *Rygchium* for North America (Hymenoptera: Vespidae). Proc. Ent. Soc. Wash. 47:45–49. March 2.
36. H. S. Hurlbut and R. M. Bohart. Factors affecting the larvicidal action of DDT on *Culex quinquefasciatus*. J. Econ. Ent. 38:725. "December."

1946

37. A key to the Chinese culicine mosquitoes. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 961:1–23. "January."
38. R. M. Bohart and R. L. Ingram. Four new species of mosquitoes from Okinawa (Diptera: Culicidae). J. Wash. Acad. Sci. 36:46–52. February 15.
39. New species of mosquitoes from the Marianas and Okinawa (Diptera, Culicidae). Proc. Biol. Soc. Wash. 59:39–46. March 11.
40. Common caterpillars of the flower garden and their control. Southern Calif. Homes and Gardens 3(6):7, 22.
41. Tsai-Yu Hsiao and R. M. Bohart. The mosquitoes of Japan and their medical importance. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 1095:1–44. September.
42. R. M. Bohart and R. L. Ingram. Mosquitoes of Okinawa and islands in the Central Pacific. Bur. Med. and Surg., Navy Dept., Washington, D.C. Navmed 1055:1–110. October.

- 43. A new species of *Halictophagus* parasitic on Cercopidae (Strepsiptera, Halictophagidae). Proc. Ent. Soc. Wash. 48:200-202. November 1.
- 44. B. V. Travis and R. M. Bohart. DDT to control maggots in latrines. J. Econ. Ent. 39:740-742. "December."

1947

- 45. Sod webworms and other lawn pests in California. Hilgardia 17:267-308. "March."
- *46. Book review: Biologie des Abeilles, by Maurice Caullery, et al. Quart. Rev. Biol. 22:222. "September."
- *47. Strepsiptera—An insect oddity. Ward's Nat. Sci. Bull. 21:28-29. "November."

1948

- 48. Contributions toward a knowledge of the insect fauna of Lower California, No. 9, Hymenoptera: Eumeninae. Proc. Calif. Acad. Sci. (4) 24:313-336. "March."
- 49. Organic phosphate insecticides: Mosquito larvae. Calif. Agric. 2(4):22-23. "April."
- 50. New North American *Rygchium* (Hymenoptera, Vespidae). Bull. Brooklyn Ent. Soc. 43:80-87. July 1.
- 51. The genus *Euparagia* in North America (Hymenoptera: Vespidae). Pan-Pac. Ent. 24:149-154. October 16.
- 52. The red *Stenodynerus* of Florida (Hymenoptera: Vespidae). Florida Ent. 31: 71-80. November 6.
- 53. A comparison of DDT and Dichlorodiphenyl Dichlorethane as larvicides for *Aedes* mosquitoes. J. Econ. Ent. 41:834-835. "October."
- 54. Differentiation of larvae and pupae of *Aedes dorsalis* and *Aedes squamiger* (Diptera, Culicidae). Proc. Ent. Soc. Wash. 50:216-218. November 30.

1949

- 55. The subgenus *Neoculex* in America north of Mexico (Diptera, Culicidae). Ann. Ent. Soc. Amer. 41:330-345. January 27 (incorrectly 1948).
- 56. Notes on North American *Polistes* with descriptions of new species and subspecies (Hymenoptera, Vespidae). Pan-Pac. Ent. 25:97-103. July 29.
- 57. The genus *Stenodynerus* in southern Arizona (Hymenoptera, Vespidae). Proc. Ent. Soc. Wash. 51:237-259. December 29.

1950

- 58. A synopsis of *Maricopodynerus* (Hymenoptera: Vespidae). Bull. Brooklyn Ent. Soc. 45:17-25. February 18.
- 59. New species of solitary Vespidae from North America (Hymenoptera, Vespidae). Proc. Biol. Soc. Wash. 63:77-81. May 25.
- 60. R. M. Bohart and W. D. Murray. DDT resistance in *Aedes nigromaculis* larvae. Proc. Papers 18th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 20-22. "August."
- 61. Observations on snow mosquitoes in California (Diptera: Culicidae). Pan-Pac. Ent. 26:111-118. September 27.

- *62. Turf pests. Northern Calif. Turf. Conf. Rept., pp. 28–31. “November.”
- 63. A new species of *Orthopodomyia* from California (Diptera, Culicidae). Ann. Ent. Soc. Amer. 43:399–404. November 17.
- 64. North American additions to the genus *Pterocheilus* (Hymenoptera, Vespidae). Proc. Biol. Soc. Wash. 63:195–200. December 29.

1951

- 65. Family Sapygidae, pp. 777–778. In: C. F. W. Muesebeck et al., Hymenoptera of America north of Mexico. Synoptic catalog. U.S. Dept. Agric. Monograph 2. July 11.
- 66. Family Vespidae, pp. 875–907. In: C. F. W. Muesebeck et al., Hymenoptera of America north of Mexico. Synoptic catalog. U.S. Dept. Agric. Monograph 2. July 11.
- 67. The Myrmecolacidae of the Philippines (Strepsiptera). Wasmann J. Biol. 9: 83–103. May 25.
- 68. S. B. Freeborn and R. M. Bohart. The mosquitoes of California. Bull. Calif. Insect Survey 1:25–78. June 8.

1952

- 69. The California species of mite-bearing *Stenodynerus* (Hymenoptera, Vespidae). Proc. Ent. Soc. Wash. 54:38–53. February 15.

1953

- 70. S. F. Bailey and R. M. Bohart. A mosquito survey and control program in Guam. J. Econ. Ent. 45:947–952. February 9 (incorrectly 1952).
- 71. A new species of *Culex* and notes on other species of mosquitoes from Okinawa (Diptera, Culicidae). Proc. Ent. Soc. Wash. 55:183–188. August 24.
- 72. R. M. Bohart, E. C. Mezger, and A. D. Telford. Observations on the seasonal history of *Aedes squamiger*. Proc. Papers 21st Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 7–9. “November.”
- 73. Three new species of *Stenodynerus* from eastern United States (Hymenoptera, Vespidae). Proc. Biol. Soc. Wash. 66:185–189. December 2.

1954

- 74. Cherry fruit sawfly. Calif. Agric. 8(3):14. “March.”
- 75. Identification of first stage larvae of California *Aedes* (Diptera, Culicidae). Ann. Ent. Soc. Amer. 47:355–366. August 17.
- 76. Some peculiarities in the distribution of mosquitoes in California. Proc. Papers 22nd Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 18–19. “July.”
- 77. S. F. Bailey, R. M. Bohart, and L. J. Booher. Mosquito control on the farm. Calif. Agric. Exp. Sta. Circ. 439, 27 pp. “August.”

1955

- 78. Book review: Insects of Micronesia, vol. I, by J. Linsley Gressitt. Pan-Pac. Ent. 31:172. December 13.
- 79. Strepsiptera, pp. 566–569. In: “A century of progress in the natural sciences, 1853–1953.” California Academy of Sciences, San Francisco. “November.”

80. The role of taxonomy in relation to ecology and control. Proc. Papers 23rd Ann. Conf. Calif. Mosq. Contr. Assoc. and 11th Ann. Meeting Amer. Mosq. Contr. Assoc., pp. 97-98. "December."
81. North American *Leptochilus* of the *trinodus* group (Hymenoptera, Vespidae). Proc. Ent. Soc. Wash. 57:287-299. December 22.

1956

82. R. M. Bohart and A. H. Smith. Radioisotopes for evaluation of a fly nuisance source. Calif. Vector Views 3:5, 7. "February."
83. New species of mosquitoes from the southern Ryukyu Islands. Bull. Brooklyn Ent. Soc. 51:29-34. May 11.
84. R. M. Bohart and E. I. Schlinger. Descriptions of two new western *Oxybelus* (Hymenoptera: Sphecidae). Proc. Biol. Soc. Wash. 69:37-39. May 21.
85. A. H. Smith and R. M. Bohart. Evaluating fly nuisance source. Calif. Agric. 10(7):11-12. "July."
86. Identification and distribution of *Aedes melanimon* and *Aedes dorsalis* in California. Proc. Papers 24th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 81-83. July 30.
87. E. C. Loomis, R. M. Bohart, and J. N. Belkin. Additions to the taxonomy and distribution of California mosquitoes. Calif. Vector Views 3:37-45. "August."
88. R. M. Bohart and J. A. Powell. Observations on the nesting habits of *Eucerceris flavocincta* Cresson (Hymenoptera: Sphecidae). Pan-Pac. Ent. 32:143-144. August 14.
89. R. M. Bohart and E. I. Schlinger. New species of *Oxybelus* from western North America (Hymenoptera: Sphecidae). Pan-Pac. Ent. 32:147-156. November 7.
90. R. M. Bohart and E. I. Schlinger. An annotated synonymical list of North American *Oxybelus* (Hymenoptera: Sphecidae). Pan-Pac. Ent. 32:157-165. November 7.

1957

91. Insects of Micronesia: Culicidae. Insects Micronesia 12:1-85. January 21 (incorrectly 1956).
92. R. M. Bohart and R. C. Bechtel. The social wasps of California (Vespinae, Polistinae, Polybiinae). Bull. Calif. Insect Survey 4:73-101. March 1.
- *93. Five years of fly control on an agricultural university campus. Calif. Vector Views 4:23, 25, 26. "April."
94. R. M. Bohart and E. I. Schlinger. California wasps of the genus *Oxybelus* (Hymenoptera: Sphecidae, Crabroninae). Bull. Calif. Insect Survey 4:103-142. April 11.
95. Biological studies, mosquito control, and the entomologist. Proc. Papers 25th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 78-79. "July."
96. R. M. Bohart and R. K. Washino. Differentiation of second and third stage larvae of California *Culex* (Diptera: Culicidae). Ann. Ent. Soc. Amer. 50:459-463. September 15.

1958

97. E. C. Loomis, R. M. Bohart, and J. N. Belkin. Insecticides for control of

flies on poultry ranches, dairies, homes, and food processing plants. Univ. Calif. Agric. Ext. Serv. (unnumbered bulletin), 10 pp. "June" [also printed in Calif. Vector Views 5:35-41 (June)].

98. A North American species of the genus *Prosopigastra* (Hymenoptera, Sphecidae). Proc. Ent. Soc. Wash. 60:122-124. "June."
99. R. M. Bohart and H. K. Court. New species of *Lindenius* from western North America (Hymenoptera: Sphecidae). Pan-Pac. Ent. 34:161-167. July 22.
100. A new *Priononyx* and a key to the North American species (Hymenoptera: Sphecidae). Bull. Brooklyn Ent. Soc. 53:90-93. October 15.

1959

101. New species of *Aphilanthops* from western North America (Hymenoptera, Sphecidae). Ann. Ent. Soc. Amer. 52:105-108. January 20.
102. R. M. Bohart, D. H. Ecke, J. Fowler, and other collaborators. In: E. C. Loomis, ed., A field guide to the common mosquitoes of California. Ent. Committee, Calif. Mosq. Contr. Assoc., 27 pp. "February."
103. A survey of the mosquitoes of the southern Ryukyus. Mosq. News 19:194-197. "September."

1960

104. R. M. Bohart and L. E. Campos. A review of the genus *Omalus* Panzer in North America (Hymenoptera, Chrysididae). Ann. Ent. Soc. Amer. 53:235-250. March 31.
105. Addendum to a review of the genus *Omalus* Panzer in North America (Hymenoptera, Chrysididae). Ann. Ent. Soc. Amer. 53:435. May 31.
106. R. M. Bohart and P. M. Marsh. Observations on the habits of *Oxybelus sericeum* Robertson. Pan-Pac. Ent. 36:115-118. August 9.

1961

107. R. M. Bohart and A. S. Menke. A review of the genus *Palmodes* in North America (Hymenoptera: Sphecidae). Proc. Ent. Soc. Wash. 63:179-191. November 22.
108. The art and practice of key-making in Entomology. Verhandl. XI Internat. Kong. Ent., Wien, 1960. 1:17-19. December (incorrectly 1962).

1962

109. *Gorytes (Gorytes) mcateei* Krombein and Bohart, new species, pp. 15-16. In: K. V. Krombein, Natural history of Plummers Island, Maryland, etc. Proc. Biol. Soc. Wash. 75:1-17. March 30.
110. New species of black *Tachysphex* from North America (Hymenoptera, Sphecidae). Proc. Biol. Soc. Wash. 75:33-39. March 30.
111. R. M. Bohart, D. H. Ecke, J. Fowler, and other collaborators. In: T. H. Lauret, ed., A field guide to common mosquito-like gnats of California. Ent. Committee, Calif. Mosq. Contr. Assoc., 19 pp.
112. R. M. Bohart and L. A. Stange. Lectotypes of Nearctic and Neotropical Zethini in European and American museums (Hymenoptera: Vespidae). Bull. Brooklyn Ent. Soc. 57:28-32. April 9.

113. R. M. Bohart and G. E. Bohart. A revision of the *Larropsis* subgenus *An-cistromma* Fox (Hymenoptera: Sphecidae). Proc. Ent. Soc. Wash. 64:21-37. May 1.
114. The *Tachytes pepticus* group in North America (Hymenoptera: Sphecidae). Pan-Pac. Ent. 38:117-129. June 29.
115. Book review: A catalogue and reclassification of the Indo-Australian Ichneu-monidae by Henry Townes. Bull. Ent. Soc. Amer. 8:93-94. "June."
116. A new Strepsipteran parasitic on Coreidae (Strepsiptera: Halictophagidae and Hemiptera: Coreidae). Proc. Ent. Soc. Wash. 64:91-94. August 27.
117. A review of the hexadentate species of *Chrysis* of America north of Mexico (Hymenoptera, Chrysididae). Acta Hymenopterologica 1:361-375. September 30.
118. Vector control research at the University of California, Davis. Proc. Papers 30th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 29-30. October 22.

1963

119. New species of *Pseudomasaris*, pp. 290-292, 298-299, 301. In: O. W. Rich-ards, The species of *Pseudomasaris* Ashmead (Hymenoptera: Masaridae). Univ. Calif. Publ. Ent. 27:283-310. July 3.
120. R. M. Bohart and A. S. Menke. A reclassification of the Sphecinae with a revision of the nearctic species of the tribes Sceliphronini and Sphecini (Hymenoptera, Sphecidae). Univ. Calif. Publ. Ent. 30:91-182. October 15.

1964

121. New species of *Chrysis* in the *lauta*, *propria* and *venusta* groups from North America (Hymenoptera: Chrysididae). Proc. Biol. Soc. Wash. 77:223-236. October 30.
122. Mosquito and related arthropod control activities—University of California, Davis. Proc. Papers 32nd Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 29-30. December 30.

1965

123. Synonymy of North American Odynerini described by Peter Cameron. Pan-Pac. Ent. 31:107-113. June 11.
124. R. M. Bohart and L. A. Stange. A revision of the genus *Zethus* Fabricius in the Western Hemisphere (Hymenoptera: Eumenidae). Univ. Calif. Publ. Ent. 40:1-208. September 21.
125. R. M. Bohart and A. S. Menke. *Stizus* Latreille, [1802-1803] (Insecta, Hy-menoptera): proposed designation of a type-species under the plenary pow-ers. Z. N. (S.) 1710. Bull. Zool. Nomencl. 22:255-256. "November."
126. R. M. Bohart and A. S. Menke. *Diodontus* Curtis, 1834 (Insecta, Hyme-noptera): Proposed designation of a type-species under the plenary powers. Z. N. (S.) 1711. Bull. Zool. Nomencl. 22:257-258. "November."
127. Progress in mosquito source reduction in California. Proc. Papers 33rd Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 30-31. "December."

1966

128. New species of *Ceratochrysis* from North America (Hymenoptera: Chrysi-didae). J. Kansas Ent. Soc. 39:112-123. February 21.

129. The genus *Neochrysis* in America north of Mexico (Hymenoptera: Chrysididae). Bull. Brooklyn Ent. Soc. 58:139–144. March 14 (incorrectly 1963).
130. Withdrawal of application for the designation of a type-species for *Stizus* Latreille [1802–1803]. Z. N. (S.) 1710. Bull. Zool. Nomencl. 23:7–8. April 29.
131. A. S. Menke, R. M. Bohart, and J. van der Vecht. *Podalonia* Spinola, 1853: Proposed suppression under plenary powers in favour of *Podalonia* Fernald, 1927, with *Ammophila violaceipennis* Lepeletier, 1845, as type species. Z. N. (S.) 1735. Bull. Zool. Nomencl. 23:48–51. April 29.
132. New *Stenodynerus* from North America (Hymenoptera; Eumenidae). Proc. Biol. Soc. Wash. 79:73–81. May 23.
133. F. D. Parker and R. M. Bohart. Host-parasite associations in some twig-nesting Hymenoptera from western North America. Pan-Pac. Ent. 42:91–98. June 14.
134. R. M. Bohart and J. F. Holland. Nesting habits of *Enchemicrum australe* Pate (Hymenoptera, Sphecidae, Crabroninae). Pan-Pac. Ent. 42:161. June 14.
135. A review of *Aphilanthops* and related genera (Hymenoptera: Sphecidae). Proc. Ent. Soc. Wash. 68:158–167. June 29.
136. R. M. Bohart, C. S. Lin, and J. F. Holland. Bionomics of *Oxybelus sparideus* at Lake Texoma, Oklahoma (Hymenoptera: Sphecidae: Crabroninae). Ann. Ent. Soc. Amer. 59:818–820. July 15.
137. New species of cuckoo wasps bred from twigs in western North America (Hymenoptera: Chrysididae). Proc. Biol. Soc. Wash. 79:131–134. August 15.
138. Strepsiptera. In: Encyclopedia Britannica, vol. 21, 14th edit. W. Benton, Chicago. "August" (reprinted in subsequent printings).
139. Book review: A catalogue and reclassification of the eastern Palearctic Ichneumonidae, by Henry Townes, Setsuya Momoi, and Marjorie Townes. Bull. Ent. Soc. Amer. 12:358. "September."
140. H. K. Court and R. M. Bohart. Systematic notes on crabronids with description of a new species (Hymenoptera: Sphecidae). Pan-Pac. Ent. 42:329–332. November 30.
141. G. E. Bohart and R. M. Bohart. A revision of the genus *Larropsis* Patton (Hymenoptera: Sphecidae). Trans. Amer. Ent. Soc. 92:653–685. December 16.

1967

142. New genera of Gorytini (Hymenoptera: Sphecidae: Nyssoninae). Pan-Pac. Ent. 43:155–161. July 14.
143. R. M. Bohart and R. L. Brumley. Two new species of *Hedychridium* from California (Hymenoptera: Chrysididae). Pan-Pac. Ent. 43:232–235. October 30.

1968

144. New species of *Nysson* from southwestern United States (Hymenoptera: Sphecidae). Pan-Pac. Ent. 43:315–325. February 28 (incorrectly 1967).
145. F. D. Parker and R. M. Bohart. Host-parasite associations in some twig-

nesting Hymenoptera from western North America. Part II. Pan-Pac. Ent. 44:1-6. June 28.

- 146. New *Hoplisoides* from the United States (Hymenoptera; Sphecidae). Proc. Ent. Soc. Wash. 70:287-292. October 4.
- 147. New Nyssoninae from North and South America (Hymenoptera: Sphecidae). Pan-Pac. Ent. 44:228-236. October 21.
- 148. A synopsis of the American species of the genus *Oryttus* (Hymenoptera, Sphecidae). Proc. Biol. Soc. Wash. 81:431-437. December 30.

1969

- 149. New species of *Pseudoplisus* from North and Central America. I. The *P. phaleratus* group (Hymenoptera: Sphecidae). J. Kansas Ent. Soc. 41:494-501. January 10 (incorrectly 1968).
- 150. R. M. Bohart and H. H. Laidlaw. Howard Lester McKenzie. Univ. Calif., In memoriam for 1969, pp. 102-104. "May."
- 151. R. M. Bohart and E. E. Grissell. New species of Psenini (Hymenoptera: Sphecidae). Pan-Pac. Ent. 45:216-221. October 14.
- 152. New species of *Pseudoplisus* from North America, II (Hymenoptera: Sphecidae). J. Kansas Ent. Soc. 42:392-405. October 27.
- 153. D. R. Miller, R. M. Bohart, and R. F. Wilkey. Howard Lester McKenzie, Jr. 1910-1968. Pan-Pac. Ent. 45:245-259. December 8.

1970

- 154. R. E. Eastwood, J. R. Fowler, and other collaborators including R. M. Bohart. In: J. L. Mallars and J. R. Fowler, eds., Mosquito eating fishes in California. Calif. Mosq. Contr. Assoc., Visalia, Calif., 27 pp. "June."
- 155. New species, synonymy and lectotype designations in North American Bembicini (Hymenoptera: Sphecidae). Pan-Pac. Ent. 46:201-207. August 10.
- 156. The genus *Ochleroptera* in New Guinea. Proc. Ent. Soc. Wash. 72:386-387. September 25.
- 157. Systematics of mosquitoes. Proc. Papers 38th Ann. Conf. Calif. Mosq. Contr. Assoc., p. 48. September 25.

1971

- 158. New species of Gorytini from western North America (Hymenoptera: Sphecidae). Proc. Biol. Soc. Wash. 83:445-453. February 9.
- 159. R. M. Bohart and D. S. Horning, Jr. California bembicine sand wasps. Bull. Calif. Insect Survey 13:1-49. December 30.

1972

- 160. R. M. Bohart and R. K. Washino. Changing perspectives in systematics of mosquitoes in California. Proc. Papers 40th Ann. Conf. Calif. Mosq. Contr. Assoc., pp. 126-127. August 23.
- 161. R. M. Bohart and E. E. Grissell. Nesting habits and larva of *Pulverro monticola* (Hymenoptera: Sphecidae). Pan-Pac. Ent. 48:145-149. September 28.
- 162. R. M. Bohart and R. O. Schuster. A host record for *Fedtschenkia* (Hymenoptera: Sapygidae). Pan-Pac. Ent. 48:149. September 28.

163. New North American *Philanthus* (Hymenoptera: Sphecidae). Proc. Ent. Soc. Wash. 74:397–403. December 30.

1974

164. A. S. Menke, R. M. Bohart, and O. W. Richards. Proposed emendation to Nysson of the name *Nysson* Latreille, 1796 (Hymenoptera, Sphecidae). Z. N. (S.) 2055. Bull. Zool. Nomencl. 30:217–218. June 28.
165. A. S. Menke, R. M. Bohart, and O. W. Richards. *Euplilis* Risso, 1826 (Hymenoptera, Sphecidae): Proposed suppression under the plenary powers in favor of *Rhopalum* Stephens, 1829. Z. N. (S.) 2056. Bull. Zool. Nomencl. 39:219–220. June 28.
166. R. M. Bohart and A. S. Menke. Names of some North American vespoid wasps (Hymenoptera: Vespidae and Eumenidae). J. Kansas Ent. Soc. 47: 459–469. October 30.
167. M. L. Siri and R. M. Bohart. A review of the genus *Mellinus* (Hymenoptera: Sphecidae). Pan-Pac. Ent. 50:169–176. November 8.
168. A review of the genus *Rhopalum* in America north of Mexico (Hymenoptera: Sphecidae). J. Georgia Ent. Soc. 9:252–260. November.

1975

169. Comment on the proposed suppression of *Euplilus* Risso, 1826 in favour of *Rhopalum* Stephens, 1829. Z. N. (S.) 2056. Bull. Zool. Nomencl. 32:98. "June."
170. R. M. Bohart and E. E. Grissell. California wasps of the subfamily Philanthinae (Hymenoptera: Sphecidae). Bull. Calif. Insect Survey 19:1–92. August 1.

1976

171. C. J. Mitchell and R. M. Bohart. Mosquito control on the farm. University of California, Div. Agric. Sci., Coop. Ext., Leaflet 2850, 14 pp. "January."
172. R. M. Bohart and A. S. Menke. Sphecid wasps of the world. A generic revision. University of California Press, Berkeley and Los Angeles, ix + 695 pp. April 27.
173. A review of the nearctic species of *Crabro* (Hymenoptera: Sphecidae). Trans. Amer. Ent. Soc. 102:229–287. "July."
174. R. M. Bohart and A. S. Menke. Reply to Dr. Krombein's comment on our proposal to suppress *Euplilis* Risso, 1826. Z. N. (S.) 2056. Bull. Zool. Nomencl. 33:68. "September."
175. Comment on the application concerning *Notozus* Forster, 1853. Z. N. (S.) 2109. Bull. Zool. Nomencl. 33:72. "September."

1977

176. R. M. Bohart and L. Stange. *Liogorytes joergenseni* (Brethes), a cicada killer in Argentina (Sphecidae, Nyssoninae). Pan-Pac. Ent. 52:313. March 27 (incorrectly 1976).
177. R. M. Bohart and B. Villegas. Nesting behavior of *Encopognathus rufiventris* Timberlake (Hymenoptera: Sphecidae). Pan-Pac. Ent. 52:331–334. March 27 (incorrectly 1976).

1978

- 178. R. M. Bohart and N. J. Smith. A revision of Nearctic *Ammoplanops* (Hymenoptera, Sphecidae). J. Kansas Ent. Soc. 51:75-90. January 26.
- 179. R. M. Bohart and R. K. Washino. Mosquitoes of California. 3rd edit. University of California, Div. Agric. Sci., Berkeley, Publication Number 4084, viii + 153 pp. March.
- 180. R. M. Bohart and M. E. Irwin. A study of stylopization in the bee genus *Dufourea*. Pan-Pac. Ent. 54:98-102. September 5.
- 181. R. M. Bohart and L. S. Kimsey. A revision of the New World species of *Hedychridium* (Hymenoptera, Chrysididae). Proc. Biol. Soc. Wash. 91:590-635. December 6.

1979

- 182. *Tachytes* of South America (Hymenoptera, Sphecidae, Larrinae). Trans. Amer. Ent. Soc. 104:435-505. February 20.
- 183. A. S. Menke and R. M. Bohart. Sphecid wasps of the world: Errors and omissions (Hymenoptera: Sphecidae). Proc. Ent. Soc. Wash. 81:111-124. February 28.
- 184. R. M. Bohart and J. D. McLaughlin. Evidence indicating *Ammophila* (Hymenoptera: Sphecidae) as host of *Spintharosoma* (Hymenoptera: Chrysididae). Pan-Pac. Ent. 54:310. April 5 (incorrectly 1978).
- 185. R. M. Bohart and L. S. Kimsey. A key to the species of *Ectemnius* in America north of Mexico with notes and description of a new species (Hymenoptera: Sphecidae). Proc. Ent. Soc. Wash. 81:486-498. August 13.

1980

- 186. New genera and species of North American Chrysididae (Hymenoptera). J. Kansas Ent. Soc. 53:132-136. January 2.
- 187. R. M. Bohart and L. S. Kimsey. A generic synopsis of the Chrysididae of America north of Mexico. J. Kansas Ent. Soc. 53:137-148. January 2.
- 188. A review of the North American species of *Dienoplus* (Hymenoptera: Sphecidae). Pan-Pac. Ent. 56:63-70. January 24.
- 189. The Middle American species of *Stenodynerus* (Hymenoptera, Eumenidae). Polskie Pismo Ent. 50:71-108. March 30.

1981

- 190. L. S. Kimsey and R. M. Bohart. A synopsis of the chrysidid genera of neotropical America (Chryridoidea, Hymenoptera). Psyche 87:75-91. April 27 (incorrectly 1980).

1982

- 191. R. M. Bohart and L. S. Kimsey. A synopsis of the Chrysididae in America north of Mexico. Mem. Amer. Ent. Inst. 33:1-266. March 8.
- 192. *Leucodynerus*, a new genus of solitary wasps from western North America (Hymenoptera: Sphecidae [correctly Eumenidae]). J. Kansas Ent. Soc. 55:442-446. July 20.
- 193. New species of *Stictiella* (Hymenoptera: Sphecidae). J. Kansas Ent. Soc. 55:593-597. July 20.

Gall-inducing Cynipid Wasps from *Quercus dunnii* Kellogg (Hymenoptera)

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The cynipid fauna on the oak *Quercus (Protobalanus) dunnii* Kellogg previously has received little study partly because of its restricted ecological and geographical distributions. *Quercus dunnii* occurs sporadically in the sagebrush-chaparral ecotone. Its range is a narrow horizontal band extending from southwest Arizona and northern Baja California, Mexico, around the western edge of the Mojave Desert (Tucker and Haskell, 1960), in San Benito County, California (Griffin and Tucker, 1976), and north to the inner coast range west of Byron, Contra Costa County, California (Tucker *et al.*, 1982).

The only prior cynipid host record for *Q. dunnii* (Weld, 1957) listed *Disholcaspis chrysolepidis* (Beutenmuller) and two undescribed stem galls. The present paper reports an additional 8 unisexual and 1 bisexual generation gall-inducing cynipid wasps including 4 newly described species (*Trichoteras burnetti*, *Loxaulus boharti*, *Heteroecus fragilis* and *Heteroecus lyoni*; all unisexual generations) and five new host records. Type specimens placed in the U.S. National Museum and the California Academy of Sciences are indicated with the abbreviations USNM and CAS respectively. Those placed in the L. H. Weld collection are in the possession of Robert J. Lyon, Los Angeles City College, Los Angeles, Calif.

BIOGEOGRAPHY

Q. dunnii has a highly disjunct relict distribution, occasionally only single trees. As is typical for island faunas each local oak population supports only a few cynipid species, particularly in the northern end of the range. This scattered distribution pattern provides a potential for rapid evolution and/or extinction of new species and requires widespread collecting to determine the current total fauna of this oak. The galls of numerous additional undescribed cynipids, probably the alternate bisexual generations, have been seen or collected from *Q. dunnii* but they will not be described until insects can be reared.

The 3 subgenera of American oaks have no gall-inducing cynipids in common, but most gall-inducing cynipids occur on more than 1 oak species within a subgenus. The cynipids on *Lepidobalanus*, or white oaks, and *Erythrobalanus*, or red and black oaks, of the Southwest and the Pacific slope are generally distinctive, with only 1 species known from both regions (R. J. Lyon, pers. comm.). But for some reason a different pattern occurs in the *Protobalanus* oaks. Some of the species listed in this paper on *Q. dunnii* occur in both the Pacific slope and the Southwest. An even more widespread distribution of the gall-inducing cynipids occurs on the more montane *Quercus chrysolepis* Leibmann. The cynipids on *Q. dunnii* with the widest geographic distribution are those which also occur on other *Protobalanus* oaks. The host patterns of these insects have not been generally appreciated because Weld (1960) routinely listed *Q. chrysolepis*, *Q. dunnii* and hybrids between these two species in Arizona all as *Q. wilcoxii*. In Weld (1957)

Quercus palmeri is a synonym of *Q. dunnii*. The differences in the evolutionary history of the three American oak subgenera and the atypical geographic pattern of the *Protobalanus* cynipid faunas in these two regions are not yet understood.

***Trichoteras burnetti* Dailey and Sprenger, NEW SPECIES**

(Fig. 2)

Unisexual generation female holotype.—Head: pubescent, reticulate; from above transverse; slightly narrower than thorax; cheeks widened behind eyes; occiput not elevated above general head contour; malar space 0.4 eye height, not grooved; antenna 13 segmented, filiform, segment 1 longer than 2, segment 3 equal to 4 or 1 plus 2, 13 twice the length of 12. Thorax: mesoscutum polished, micropunctate throughout, as broad as long, pubescent, profile normal; anterior parallel lines absent; notauli complete, close together throughout and nearly meeting posteriorly, twice as wide posteriorly as anteriorly; parapsidal lines and median groove absent; scutellum pubescent, punctate; fovea indistinct, coriaceous, weakly longitudinally ridged with slightly stronger median ridge; mesopleuron shiny, pubescent, punctate. Wings normal sized, hyaline, with fine pubescence, margin ciliate, veins light brown, radial cell open, aerolet 0.1 first cubital cell length. Claws toothed. Abdomen: propodeum smooth, polished, without median carina; length less than head plus thorax, tergites II and III smooth, polished, pubescent anteriorly; ventral spine stout but evenly tapering, 3 times as long as high or wide, bristly, shorter than basal hind tarsal segment. Using maximum head width as base, mesonotum length is 1.5, antenna 2.3, wing 5.5. Body length is 2.5 mm. Color of head, thorax, legs, and abdomen light brown, antennae brown, darkest distally.

Host.—*Quercus dunnii*.

Variation.—Size range of 28 specimens: 1.8–2.7 mm, average 2.1 mm.

Gall.—Yellow, highly pubescent aborted axillary bud or leaf petiole gall; polythalamous with angular basal larval cells; diameter 1.0–3.0 cm (Fig. 2 and Weld, 1957, Fig. 163).

Biology.—Pupation occurs in September. Insects reared by Burnett emerged during December and January and were observed to oviposit between axillary bud scales but no galls developed.

Type material.—Holotype ♀, 3 ♀ paratypes: CALIFORNIA, *Riverside Co.*, ca. 12 km E Anza, reared from 5 galls coll. from a single plant (Dailey #1263). Additional paratypes reared as follows: MEXICO, *Baja California (Norte)*, El Condor (12 galls and 29 ♀, Dailey #1168); CALIFORNIA, *Riverside Co.*, 12 km E Hemet (4 galls, 43 ♀), Dr. John Burnett. All material in Dailey collection except holotype ♀ and 2 paratype ♀ and galls in USNM; 2 paratype ♀ and galls in CAS; 2 paratype ♀ in Weld collection.

Distribution.—In addition to the above localities, *T. burnetti* was recorded by Weld (1957) from galls collected in the San Jacinto Mountains, California on *Q. palmeri* (= *Q. dunnii*).

Discussion.—*Trichoteras burnetti* is the only gall on *Q. dunnii* which is polythalamous and covered with dense, thick pubescence and is the only bud or leaf-petiole gall. It resembles *Andricus lasius* McCracken and Egbert which occurs on other oak species. It is listed as species #2 in Weld's manuscript key to *Trichoteras* in the possession of Mr. Robert J. Lyon. Adult females may be distinguished from

related species by the shorter ventral spine which is only 3 times as long as wide or high.

Etymology.—Named for Dr. John Burnett who first reared this species.

***Trichoteras rotundula* Weld: NEW HOST RECORD**

(Fig. 1)

This unisexual generation monothalamous, hollow, thin-walled, spherical leaf gall with central larval cell supported by filaments is attached to lower veins, occasionally in clusters (Fig. 1 and Weld, 1957, Fig. 91).

Host.—*Quercus dunnii*, *Q. chrysolepis*.

Biology.—Galls are fully grown by summer and females emerge in October and November. The insect specimens range from 2.0 to 2.6 mm in body length.

Distribution.—Specimens emerged from galls collected near Hemet Lake, Riverside County, California by Dr. John Burnett. Similar galls were collected by us at Sedona, Coconino County, Arizona and El Condor and Melling Ranch, Baja California (Norte), Mexico.

***Andricus chrysobalani* Weld: NEW HOST RECORD**

This is a bisexual generation which emerges from cells in the inner margins of the acorn cups and/or outer acorn hull during August. Insects emerged in mid-August from galls collected east of Anza, Riverside County, California (Dailey #1292). Similar galls were seen at Sedona, Coconino County, Arizona (Dailey #1289).

***Andricus reniformis* McCracken and Egbert: NEW HOST RECORD**

Galls of *Andricus reniformis* have been collected at Sedona, Coconino County, Arizona. These galls are similar to those of *Disholcaspis truckeensis* (Ashmead) which Weld recorded on "*Quercus wilcoxii*" in Arizona. Weld's listings of *Q. wilcoxii* include *Q. chrysolepis*, *Q. dunnii* or hybrids between these two oaks.

***Disholcaspis chrysolepidis* (Beutenmuller)**

Disholcaspis chrysolepidis is a unisexual generation which produces an elongate stem gall, dark brown and convex on top and lighter in color and concave on both sides (Weld, 1957, Fig. 52). It has been found 10 km east of Anza, Riverside County, and 16 km northeast of Cajon Pass, San Bernardino County, California.

***Disholcaspis truckeensis* (Ashmead): NEW HOST RECORD**

Galls of *Disholcaspis truckeensis* were collected in the Haḡlaupi Mountains south of Kingman, Mojave County and Sedona, Coconino County, Arizona and from a single isolated tree 16 km northeast of Cajon Pass, San Bernardino County, California. This gall is similar to those of the bisexual generation of *Loxaulus trizonalis* Weld.

Hosts.—*Quercus dunnii*, *Q. chrysolepis*, and *Q. vaccinifolia* Kellogg.

The two species of *Disholcaspis* on *Protobalanus* oaks are distinctive from the other members in this genus (Burnett, 1977). This is also true for the 5 species of *Andricus* on *Protobalanus* oaks. All 7 species are sufficiently similar to each

other that their life histories should be determined and their collective generic assignment reassessed.

***Loxaulus boharti* Dailey and Sprenger, NEW SPECIES**
(Fig. 3)

Unisexual generation female holotype.—Head: coriaceous; from above massive; broader than thorax; cheeks widened behind eyes; occiput rounded, only slightly elevated above contour of head; malar space 0.3 eye height, grooved, inner-ocular margins parallel; antenna 13 segmented, filiform, segment 1 longer than 2, segment 3 less than 4 or 1 plus 2, segment 13 twice the length of 12. Thorax: mesoscutum strongly transversely coriaceous, bare, as broad as long; sides of pronotum coriaceous; anterior parallel lines slightly less than 0.5 mesoscutum length; notauli incomplete, extending from posterior 0.3 mesoscutum length with short shallow depression anterior to that, wrinkled; parapsidal lines 0.4 mesoscutum length; median groove absent; scutellum weakly reticulate, slightly longer than wide; fovea indistinct, longitudinally wrinkled, separated by median wrinkle; mesopleuron aciculate. Wings pubescent, margin ciliate, veins brown, radial cell closed, aerolet 0.25 cubital cell length, basal and first abscissa of radial cell clouded. Claws simple. Abdomen: propodeum polished, slightly wrinkled, carinae straight, distinct, enclosing an area longer than wide, with distinct complete median carina; 2 tergites visible in dorsal view, length less than head plus thorax, slightly longer than high, smooth, polished, bare; ventral spine 3 times as long as high or wide. Using maximum head width as base, mesonotum length is 1.3, antenna 2.2, wing 3.5. Body length 1.8 mm. Color of head, thorax, legs, and abdomen yellow-brown; antennal segments 1-4 yellow-brown, 5-13 brown and ribbed.

Host.—*Quercus dunnii*.

Gall.—Integral stem gall, larval cells 2 mm in diameter, develop in wood under bark, stems slightly lumpy though lumps barely noticeable until insects emerge (Fig. 3). Similar to gall of *Loxaulus brunneus* (Ashmead) on *Quercus chrysolepis*.

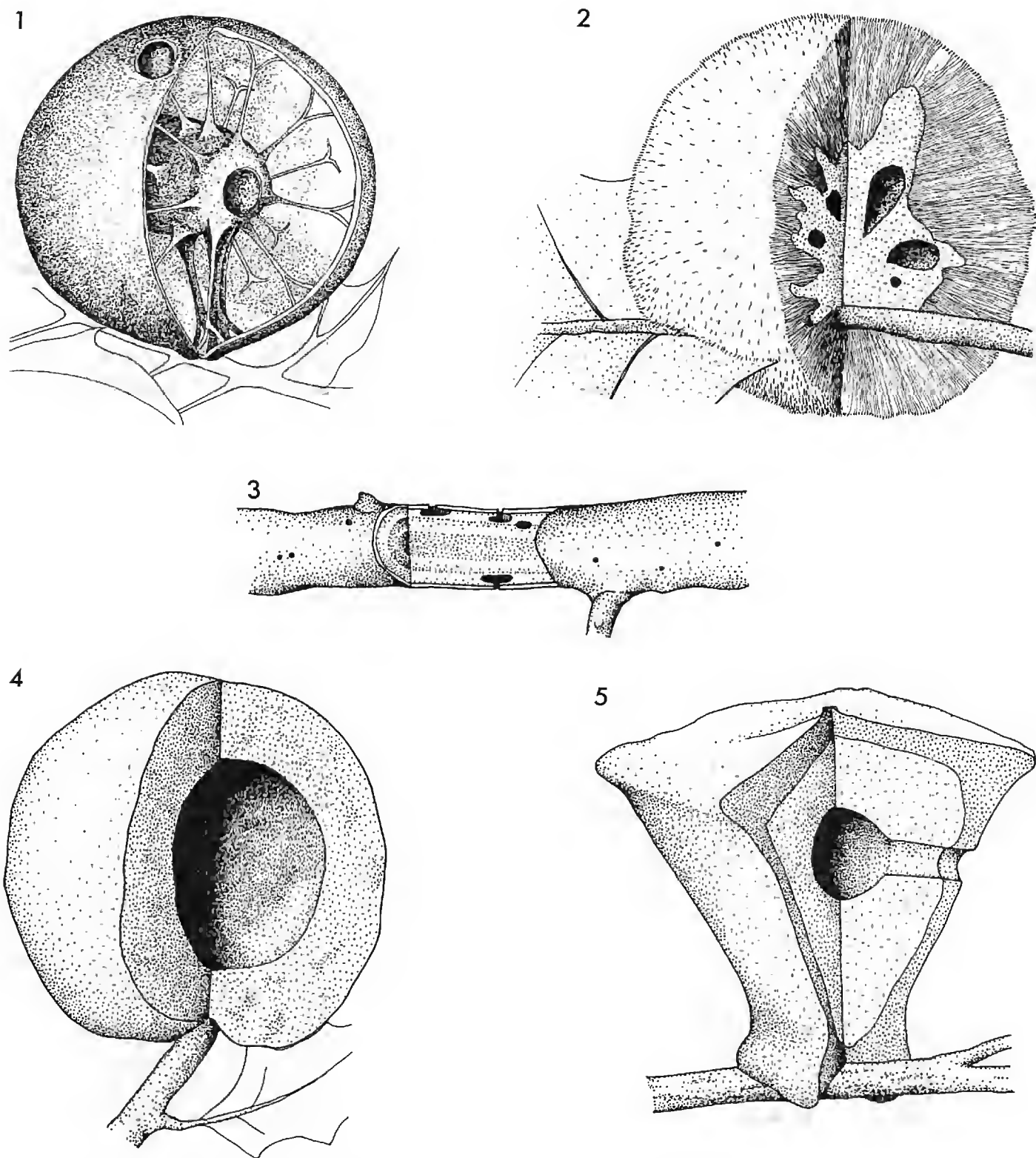
Variation.—Size range of 61 specimens 1.6-1.9 mm.

Biology.—Insects emerge in late March and early April from 2-year-old twigs and only the basal half of prior year twigs. The oviposition site is unknown but is probably in buds with bisexual generation emergence and oviposition in twigs when one-half of the current year's stem growth has occurred.

Type material.—Holotype ♀, 91 ♀ paratypes: CALIFORNIA, *San Diego Co.*, 1 km W Jacumba, reared from galls collected by us from a single shrub. All material in Dailey collection except holotype ♀, 2 paratype ♀ and 2 galls in USNM, 4 paratype ♀ and 4 galls each in CAS and Weld collections.

Distribution.—Galls similar to the above were collected at El Condor, Baja California (Norte), Mexico and 14 km east of Anza, Riverside Co., and 8 km west of Byron, Contra Costa County, California on *Quercus dunnii* and from San Carlos Canyon, Baja California (Norte), Mexico on *Q. cedrosensis* Muller. No insects were reared.

Discussion.—*Loxaulus boharti* is the only integral stem gall known from *Q. dunnii*. Adult females may be distinguished from *L. brunneus* (a similar gall-inducer on *Q. chrysolepis*) by the incomplete notauli and the ventral spine which



Figs. 1–5. Cynipid galls. 1, *Trichoteras rotundula*. 2, *T. burnetti*. 3, *Loxaulus boharti*. 4, *Heteroecus fragilis*. 5, *H. lyoni*.

is 3 times as long as wide or high. It keys to species 7 in Weld's manuscript key to *Loxaulus* in the possession of Robert Lyon.

Etymology.—This species is named for Dr. R. M. Bohart who has aided both of us in our studies of cynipids.

***Heteroecus fragilis* Dailey and Sprenger, NEW SPECIES**
(Fig. 4)

Unisexual generation female holotype.—Head: coriaceous; from above transverse; slightly narrower than thorax; cheeks not widened behind eyes; occiput flattened, elevated above the head contour; malar space 0.5 eye height, not grooved;

antenna 14 segmented, filiform, segment 1 longer than 2, segment 3 longer than 4 or 1 plus 2, segment 14 one and one-third times the length of 13. Thorax: mesoscutum coriaceous throughout; as broad as long, sparsely pubescent; anterior parallel lines distinct, slightly longer than 0.5 mesoscutum length, weak transverse rugosity between lines; notauli incomplete, extending from posterior 0.6 mesoscutum length, sharp edged, pitted; parapsidal lines distinct, from posterior 0.5 mesoscutum length; median groove weak, 0.2 mesoscutum length; scutellum irregularly rugose, sparsely pubescent; fovea wrinkled, polished, bare, separated by a ridge; mesopleuron aciculate, bare. Wings hyaline, setae not projecting beyond margin, veins yellow, radial cell open, aerolet 0.3 length of first cubital cell. Claws simple. Abdomen: propodeum with weak median carina; length greater than head plus thorax, tergum II smooth, polished, bare dorsally, slightly pubescent anteriolaterally, micropunctate on posterior margin; ventral spine 10 times as long as high. Using maximum head width as base, mesonotum length is 1.3, antenna 2.3, wing 4.0. Body length is 2.7 mm. Color of head, thorax, legs, and abdomen dark red-brown, first six antennal segments yellow-brown, antennal segments 7-14 brown.

Host.—*Quercus dunnii*.

Gall.—Detachable, monothalamous stem gall with a thick wall formed from many small, fragile, sponge-like chambers. Yellow, spherical, 5-8 mm in diameter (Fig. 4).

Biology.—Insects had emerged from most galls collected 29 March 1972, however the collection did yield one adult insect. Oviposition site of the unisexual generation is unknown. Gall position indicates the eggs for the unisexual generation are laid in buds in the spring or early summer.

Type material.—Holotype ♀: MEXICO, Baja California (Norte), El Condor, reared from gall on *Quercus dunnii* (Dailey #1239). Paratype galls: ARIZONA: 3, Mojave Co., Haulapi Mountains. CALIFORNIA: 1, San Luis Obispo Co., Paso Robles. MEXICO: Baja California (Norte): 3, Mike's Sky Ranch; 48, El Condor; 4, Melling Ranch. All specimens in Dailey collection except holotype ♀ and 4 paratype galls in USNM, 4 paratype galls in CAS, and 2 paratype galls in Weld collection.

Discussion.—*Heteroecus fragilis* is the only gall on *Q. dunnii* which is monothalamous, spherical, and has thick, spongy walls (Fig. 4). *Trichoteras burnetti* (Fig. 2) is spherical but is polythalamous with thick pubescence and *T. rotundula* (Fig. 1) is spherical but is hollow, with paper-thin walls. *Disholcaspis truckeensis* is spherical but is polythalamous.

Etymology.—This species is named for the fragile gall texture.

***Heteroecus lyoni* Dailey and Sprenger, NEW SPECIES** (Fig. 5)

Unisexual generation female holotype.—Head: coriaceous; from above transverse; narrower than thorax; cheeks not widened behind eyes; occiput flattened, elevated above contour of head; malar space 0.5 eye height, not grooved; antenna filiform, 14 segmented, segment 1 longer than 2, segment 3 longer than 4 or 1 plus 2, segment 14 one and one-half times the length of 13. Thorax: mesoscutum coriaceous, broader than long, sparsely pubescent; anterior parallel lines distinct, more than 0.5 mesoscutum length; notauli incomplete, from posterior 0.7 meso-

scutum length, smooth, polished; parapsidal lines distinct, extending from posterior 0.5 mesoscutum length; median groove indistinct, 0.1 mesoscutum length; scutellum rugose, sparsely pubescent; fovea smooth, polished, bare, separated by a ridge; mesopleuron aciculate. Wings hyaline, setae not projecting beyond margin, veins yellow-brown, radial cell closed, aerolet 0.2 first cubital cell length. Claws simple. Abdomen: propodeum reticulate, pubescent, without median carina; length greater than head plus thorax; tergum II smooth, polished, bare, very short pubescence on ventral-posterior edge of tergum II; ventral spine long and thin, 10 times as long as high or wide, evenly tapering, sparsely pubescent. Using maximum head width as base, mesonotum length is 1.4, antenna 2.5, wing 5.4. Body length is 2.5 mm. Color of head, thorax, and abdomen is red-brown, legs and antennae are yellow.

Host.—*Quercus dunnii*.

Gall.—Detachable, monothalamous, hard, brown stem gall about as wide as tall with flaring sides and flat top 5–11 mm in diameter with an elevated central spot (Fig. 5, see also Weld, 1957, Fig. 164).

Variation.—Body length range of 27 specimens is 2.3 to 2.7 mm, average 2.6 mm. Both insects from Paso Robles have lighter colored wing veins. The color range for specimens from 8 miles east of Hemet is from amber to dark brown. Mesoscutum texture occasionally approaches weak transverse rugosity. Galls from Paso Robles and Clear Creek, San Benito County, California and some from El Condor, Baja California Norte, Mexico have nearly straight ribbed sides and a depressed central top. Those developing from axillary buds typically have a groove on the side adjacent to the stem.

Biology.—Mature galls were collected in November and insects emerged indoors in the rearing containers in late winter or early spring. The oviposition site and alternate generation are unknown.

Type material.—Holotype ♀, 12 ♀, 3 gall paratypes: MEXICO, *Baja California (Norte)*, El Condor, C. Dailey. Additional paratypes as follows: MEXICO, *Baja California (Norte)*, Mike's Sky Ranch. CALIFORNIA, 5 ♀, 28 galls, *Riverside Co.*, 10 km E Anza, C. Dailey; 2 ♀, 68 galls, *San Luis Obispo Co.*, Clear Creek, J. Tucker. All specimens in Dailey collection except holotype ♀, 4 paratype ♀ and galls each in USNM, 4 paratype ♀ and galls each in CAS and Weld collections.

Discussion.—*Heteroecus lyoni* is the only gall on *Q. dunnii* with the peculiar flaring sides and flat top as shown in Fig. 5. *Disholcaspis chrysolepidis* might rarely be confused with *H. lyoni*, but the former is mushroom-shaped and usually occurs clumped together in rows.

Etymology.—This species is named in honor of Mr. Robert J. Lyon who has worked out many cynipid life cycles including the first *Heteroecus* life history. He has provided much valuable assistance and encouragement in these studies.

***Heteroecus pacificus* Kinsey: NEW HOST RECORD**

Galls of this species were seen at Sedona, Coconino County, Arizona (Dailey #1289). The known hosts now include *Quercus dunnii*, *Q. chrysolepis*, *Q. tomentella* Engelman, and *Q. vaccinifolia* Kellogg.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. Richard M. Bohart, whose efforts as an instructor made this paper possible, to Dr. John M. Tucker for the Clear Creek, California

specimens, Dr. John Burnett for use of his reared specimens and Robert J. Lyon for use of the Weld collections and manuscript keys, and M. Lynn Kimsey for illustrations.

LITERATURE CITED

- Burnett, John A. 1977. Biosystematics of the new, Oak-Gallwasp genus *Weldia* of Western North America. Ph.D. Thesis, University of California, Riverside, California, 257 pp.
- Griffin, James R., and John M. Tucker. 1976. Range extension for *Quercus dunnii* in central California. *Madroño* 23:295.
- Tucker, John M., and Horace S. Haskell. 1960. *Quercus dunnii* in Arizona. *Brittonia* 12:196-219.
- Tucker, J. M., G. H. Holstein, Heather Stout, and Neil Havlik. 1982. Another range extension for *Quercus dunnii* in Central California. *Aliso* 10:321-328.
- Weld, L. H. 1957. Cynipid galls of the Pacific slope. Privately printed. Ann Arbor, Michigan, 64 pp.
- . 1960. Cynipid galls of the Southwest. Privately printed. Ann Arbor, Michigan, 54 pp.

***Diodontus boharti*, a New Species from California's North
Coast Range (Hymenoptera: Sphecidae)**

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Collecting trips to the more remote portions of California's Siskiyou Mountains, Marble Mountains, Salmon Trinity Mountains, and Yolla Bolly Mountains since 1965 have added more than 30,000 specimens to the insect collection at Pacific Union College, Angwin, Napa County, California. Most of the collecting expeditions involved small groups of students who, with the author, spent about ten days at a time backpacking into the higher elevations in search of insects. The North Coast Ranges of California have a unique flora that has been described as rich in narrowly endemic species which often appear to be relicts restricted to a specific ecosystem (Whittaker, 1961). We assumed that in an area so vegetatively and geologically distinctive, we would also find a characteristic insect fauna. More than 15 years of collecting in these mountains has resulted in a number of new species and new distributional records. We suspect that there are more, but large portions of the collection have not yet been determined to species and we are still looking for systematists who would be willing to determine material for us.

Determination of wasp specimens from our collections has been done mostly by Dr. Richard Bohart. My first contact with him was in connection with a new species of *Pulverro* that I discovered in the Salmon Trinity Mountains in 1966 (Eighme, 1968). I was a bit hesitant to attempt my first description and publication of a new species, but Dr. Bohart took care of that with his good natured assurance and assistance. My immediate reaction was one of confidence with such authority as he telling me I had a good species. *Pulverro monticola* Eighme has since been collected over a wide area of northern California mountains.

It was Richard Bohart who encouraged me to work on the genus *Diodontus*. I am grateful to him for introducing me to this fascinating group of wasps and I take pleasure in naming this distinctive new species in his honor.

***Diodontus boharti* Eighme, NEW SPECIES**

Holotype male. — Black; mandibles (central portion), palps, apical $\frac{1}{2}$ of pronotal lobe, spot on anterior portion of tegula, front side of all tibiae golden yellow; basal tarsomere of foreleg dusky yellow; wings dusky, iridescent, wing veins and stigma dark brown; labrum shallowly notched, clypeal teeth prominent; flagellomeres V–X with apical margins arcuate, flagellomeres VIII–X with oval, smooth, shiny tyli, flagellomere XI with small basal tylus and apical smooth shiny spot; frons and vertex with large punctures separated by less than puncture diameter, microsculpture finely linear, upper $\frac{1}{2}$ of frontal line a weak carina; pronotal collar with humeral angles sharp but not produced upward; scutum with dense punctures slightly smaller than those on the head, no microsculpture, admedian lines prominent, raised and broader than the notauli which are also prominent, parapsidal lines obscure; scutellum with faint median line; propodeum coarsely reticulate

with blunt lateral spine posterad from the spiracular flange; abdomen with fine setigerous punctures connected by fine reticulated microsculpture, tergum VI with spinose tubercles on posterior margin bearing 3 spines, sternal brushes weak; basal tarsomeres straight; omaulal ridge strong, sharp, joining postspiracular carina by a lateral extension at right angle.

Allotype female.—Black; mandibles (central portion), spot on anterior portion of tegula golden yellow; palps brown; tibiae orange-brown with darker spot on posterior side; wings dusky, iridescent, wing veins and stigma black; clypeal teeth prominent, lateral teeth twice as long as medial one; frontal spine prominent but blunt, orbital foveae narrow, extending from mid-orbit to vertex; frons and vertex with widely scattered large punctures, microsculpture fine reticulation; pronotal collar with coarse longitudinal striations at crest, humeral angles slightly winged; scutum with widely scattered punctures of same size as those on vertex plus smaller punctures densely concentrated on anterior portion, admedian lines distinct, notauli faint, parapsidal lines long, distinct; scutellum punctured like posterior scutum, propodeum coarsely reticulate with blunt lateral spine; abdomen finely punctured with reticular microsculpture; omaulal carina similar to male but not as prominent; pygidium flat with lateral border of coarse white setae.

Type material.—Holotype ♂ and allotype ♀: CALIFORNIA, *Siskiyou Co.*, Bear Basin, 7000', August 9, 1967, Lloyd Eighme, deposited at California Academy of Sciences, San Francisco. There are 21 paratypes as follows (all from California, all deposited at Pacific Union College, except as noted): *Del Norte Co.*, Stevens Camp; *Glenn Co.*, Plaskett Meadows; *Siskiyou Co.*, Rattlesnake Meadow; *Trinity Co.*, Deadfall Lakes, Mirror Lake, Red Mt. Meadows, Swift Creek (University of California, Davis), Ward Lake.

Discussion.—The coarse sculpturing of the frons and vertex is distinctive in this species. *D. boharti* resembles *D. vallicolae* in some ways but differs markedly in that it lacks the modified scutal margin seen in *D. vallicolae*, and the male has spinose tubercles on tergum VI which relate it to a different species group. Coloration may vary from the holotype in that darker specimens have no yellow on the pronotal lobe or tegula. Varying amounts of yellow pigmentation is evident in most species of this genus, so that structural characteristics have been selected as much as possible to separate the species. I originally recognized this new species from a few specimens I collected in Bear Basin, Siskiyou County in 1967. One of my students, Terry Griswold, collected 23 specimens in the Swift Creek area of Trinity County in 1972, and since then other specimens have been taken at various sites in the North Coast Range.

LITERATURE CITED

- Eighme, Lloyd E. 1968. A new species of *Pulverro* from California. *Pan-Pac. Ent.* 44:261-264.
Whittaker, R. H. 1961. Vegetation history of the Pacific Coast States and the "central" significance of the Klamath Region. *Madroño* 16(1):5-23.

**The Larva of *Ammatomus icarioides* (Turner)
(Hymenoptera: Sphecidae, Nyssoninae)**

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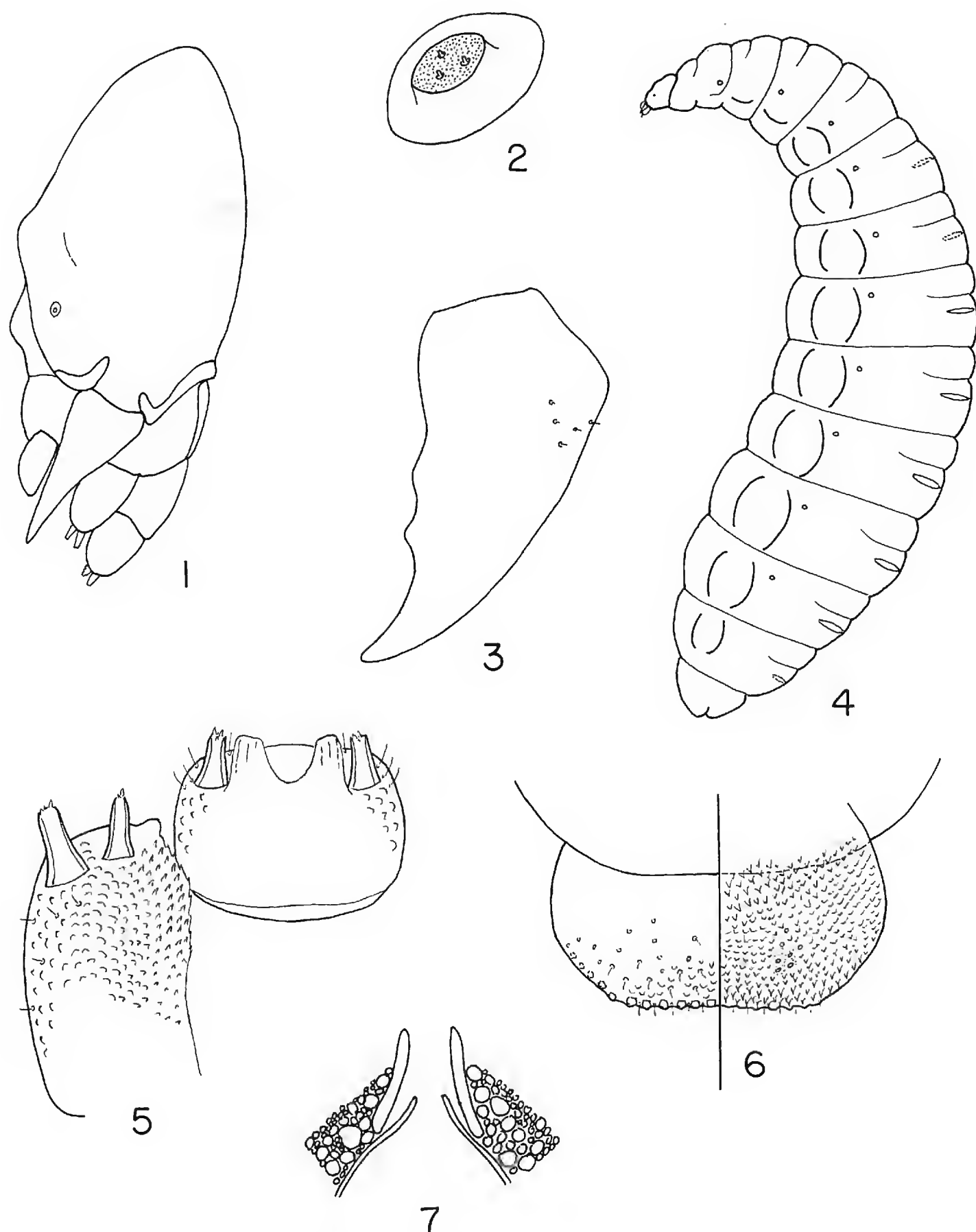
There are few groups of insects more rewarding to ethologically inclined biologists than digger wasps. They were favorites of Fabre, and since his time they have been the subject of innumerable books and scientific papers. Yet for many years Sphecidae were taxonomically a forbidding group, in which accurate species identifications were hard to come by and the higher classification fraught with difficulties. Problems still exist, and perhaps always will, but the picture has changed dramatically for the better, thanks in large part to Richard Bohart and the many students he has trained. The rewards of this research and teaching will be reaped for many years in terms of increased depth of knowledge of these most elegant of insects.

The present paper purports to fill only a tiny gap in our understanding of sphecid phylogeny. In fact it poses a puzzle, for the larvae of *Ammatomus* have several unusual features which tend to contradict evidence from ethology and from adult structure. Nesting data (Hook, 1981) suggest that *Ammatomus icarioides* is a fairly typical member of the tribe Gorytini, while adult morphology suggests that it belongs to a complex of gorytine genera (including *Sphecius*, *Kohlia*, and others) having a rather robust thorax, approaching the Stizini (Bohart and Menke, 1976).

This study is based on seven larvae from Brisbane, Queensland, Australia, taken by Allan Hook in his recent biological study. Several cocoons from this study were also available. Voucher specimens have been placed in the Colorado State University Collections. Associated adults were identified by comparison with the type specimen in the British Museum (Natural History).

DESCRIPTION OF MATURE LARVA
(Figs. 1-7)

Body length 16 mm; maximum width 4.2 mm (Fig. 4). Integument smooth and largely devoid of setae and spines, although under high magnification scattered minute setae and surface granules can be detected. Each body segment divided dorsally into two annulets by a transverse crease, the most posterior annulet with a pair of weakly defined transverse welts; pleural lobes well developed; anus terminal. Ten pairs of equally developed spiracles present; atria lined with hexagonal cellules; opening into subatrium armed with a circlet of spines. Maximum width of head 1.04 mm; length to apex of clypeus 1.08 mm, to apex of labrum 1.3 mm. Front of head with five somewhat nipple-shaped callosities, three of them in a series just below and mesad of antennae, two somewhat above antennae (these callosities are slightly brownish in color in two specimens, unpigmented in the other five). In lateral view (Fig. 1) only two of these callosities are visible. Coronal suture distinct; parietal bands indicated by short, unpigmented streaks.



Figs. 1-7. *Ammatomus icarioides*. 1-6, mature larva; 7, cocoon. 1, head, lateral view. 2, antenna. 3, mandible. 4, body, lateral view. 5, labium and maxilla, oral aspect. 6, labrum (left half) and epipharynx (right half). 7, diagrammatic cross section of cocoon pore.

Antennal orbits small, circular, containing a circular brown area in the center; this brown disc is slightly elevated above the membrane of the orbit and bears three small sensilla (Fig. 2). Head with scattered punctures, some of which bear minute setae no more than 3 times as long as width of puncture; clypeus with 24 punctures in lateral groups of 12 each.

Labrum 0.43 mm wide, apical margin straight, with a row of 22 small sensory cones; surface strongly convex, with 20 punctures on each side, most of them bearing short setae; apical margin also with several setae; surface papillose medioapically (Fig. 6). Epipharynx strongly spinulose, sensory areas each with 7 pores. Mandibles 2.1 times as long as their greatest width, weakly tridentate, each with 5 punctures toward the base laterally, punctures bearing minute setae (Fig. 3). Maxillae with small setae laterally, extensively papillose but papillae grading into small spinules on mesal margin; palpi and galeae prominent, palpi slightly longer and stouter than galeae (Fig. 5). Labial palpi equal in length to galeae, but somewhat stouter; spinnerets paired, not exceeding palpi; labium with several prominent apical setae.

DISCUSSION

Although the nesting biology of *Ammatomus icarioides* appears to differ in no important ways from that of *Gorytes* and related genera, the larva will not key readily to Gorytini in either the artificial key of Evans (1959) or the tables of Evans and Lin (1956). This is because of the absence of a distinct antennal papilla and the five protuberances on the front of the head. These protuberances are not as distinct as in Alyssonini and Nyssonini, but they are better developed than the "two pairs of vertical depressions" and the resulting interspaces described for *Gorytes*. The unusual antennae are difficult to explain. They appear to represent a stage between the development of a true papilla and the presumably ancestral condition, in which the sensilla merely arise from the membrane of the orbits.

The cocoons provide no assistance in solving this puzzle. As noted by Hook (1981), there is a single pore with a raised rim at one end. This is actually at the posterior end, opposite the cap, and resembles the pore in the cocoon of *Gorytes*, as figured by Evans (1966). This pore penetrates both the outer and inner layers of the cocoon and has a thickened rim (Fig. 7). It may represent a precursor of the more elaborate pores of *Sphecius* and of Bembicini, which are distributed around the widest part of the cocoon. In any case, there seem to be no important differences between the cocoons of *Ammatomus* and those of *Gorytes*.

We are left with the conclusions that the larvae of *Ammatomus* have probably been subjected to somewhat different selection pressures than those of other Gorytini and that the genus perhaps stands somewhat farther apart phylogenetically from *Gorytes* and from *Sphecius* than usually recognized.

LITERATURE CITED

- Bohart, R. M., and A. S. Menke. 1976. Sphecid wasps of the World. A generic revision. Univ. Calif. Press, Berkeley, 695 pp.
- Evans, H. E. 1959. Studies on the larvae of digger wasps (Hymenoptera, Sphecidae). Part V: Conclusion. Trans. Amer. Ent. Soc. 85:137-191.
- . 1966. The Comparative Ethology and Evolution of the Sand Wasps. Harvard Univ. Press, Cambridge, Mass., 526 pp.
- Evans, H. E., and C. S. Lin. 1956. Studies on the larvae of digger wasps (Hymenoptera, Sphecidae). Part II: Nyssoninae. Trans. Amer. Ent. Soc. 82:35-66.
- Hook, A. 1981. Nesting biology of *Tanyoprymnus moneduloides* and *Ammatomus icarioides*. Ann. Ent. Soc. Amer. 74:409-411.

Two New Species in the Genus *Philanthus* and a Key to the *politus* Group (Hymenoptera: Philanthidae)¹

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Bohart and Grissell (1975) arranged the North American *Philanthus* into seven species groups and provided a key for the identification of the species. An undescribed species belonging to their *P. politus* group was contained in a collection of philanthine wasps received for identification in 1980 from F. D. Parker (USDA, Bee Biology and Systematics Laboratory, Utah State University, Logan). Since this new species was difficult to place in their key, a study of the *P. politus* group was undertaken with the objective of preparing a key to accommodate the new species. A consequence of this study was the finding that the holotype of *Philanthus serrulatae* Dunning is a male of the species previously known as *Philanthus siouxensis* Mickel, a member of the *P. politus* group. The species in the *P. pacificus* group to which Bohart and Grissell (1975) had applied the name *P. serrulatae*, nec Dunning, is thus left without a name.

In Part I of this paper *P. siouxensis* is synonymized under *P. serrulatae*, and *Philanthus boharti* new species is described in the *pacificus* group to provide a name for the species previously known as *P. serrulatae*, nec Dunning. In Part II *Philanthus parkeri* new species is described in the *politus* group; the *politus* group is redefined to include *Philanthus ventilabris* Fabricius; and a key to the *politus* group is presented. Abbreviations used for institutional repositories are explained in Acknowledgments.

PART I. THE IDENTITY OF *PHILANTHUS SERRULATAE* DUNNING AND DESCRIPTION OF A NEW SPECIES IN THE *PHILANTHUS PACIFICUS* GROUP

Strandtmann (1946) treated several taxa in the genus *Philanthus* as subspecies of *Philanthus politus* Say. Bohart and Grissell (1975) synonymized *Philanthus texanus* Banks under *P. politus* and elevated the remainder of Strandtmann's subspecies to species. They placed *P. politus*, *P. psyche* Dunning, *P. siouxensis*, and *P. tarsatus* H. Smith in their *politus* group; and they placed *P. barbiger* Mickel, *P. pacificus* Cresson, *P. pulcher* Dalla Torre, and *P. serrulatae* in their *pacificus* group. The *politus* group has a metapleural lamella (= metanotal lamina of Strandtmann), whereas this structure is lacking in the *pacificus* group. This placement of *P. serrulatae* was in accord with that of Strandtmann (1946 in key, couplet 27) who stated "No metanotal lamina . . ." in characterizing the species.

Four of the specimens to which Strandtmann (1946) referred in his discussion of *P. serrulatae* were studied (OSU). Three of these (10 mi. e. Santa Fe, New Mexico; Lusk, Wyoming; Clear Creek, Colorado) have a metapleural lamella and are males of *Philanthus siouxensis*. The male from Clear Creek, Colorado, bears

¹ Oregon Agricultural Experiment Station Technical Paper No. 6589.

a label "Compared with type *P. serrulatae* D." The fourth specimen (Imperial County, California) is a male without a metapleural lamella and is conspecific with *P. serrulatae*, nec Dunning, as interpreted by Bohart and Grissell (1975). An additional five males, from Imperial County and Los Angeles, California [USNM], that Strandtmann (1946) had referred to *P. serrulatae* were also examined and found to be conspecific with the *P. serrulatae*, nec Dunning, of Bohart and Grissell (1975). It was apparent that Strandtmann had two species before him. The male holotype of *P. serrulatae* was studied and found to be a male of *P. siouxensis* and conspecific with the above males from New Mexico, Wyoming and Colorado.

***Philanthus serrulatae* Dunning**

Philanthus serrulatae Dunning, 1898:154. Male holotype, Denver, Colorado; ANSP.

Philanthus siouxensis Mickel, 1916:406. Female holotype, Harrison, Nebraska; NEB. Bohart and Grissell, 1975:6,7 (in key); Bohart and Menke, 1976:566; Krombein, 1979:1725. **New Synonymy.**

Philanthus politus serrulatae, Strandtmann, 1946:83 (in part).

Philanthus politus siouxensis, Strandtmann, 1946:91.

Specimens examined.—71 ♂, 82 ♀, including the male holotype of *P. serrulatae* and two female paratypes of *P. siouxensis*.

Distribution.—From South Dakota and Wyoming south through the Rocky Mountains and high plains to Arizona, New Mexico and Texas. In Mexico it occurs in the states of Chihuahua, Coahuila, Durango, San Luis Potosi, Zacatecas, Aguascalientes and Mexico. From Colorado northward dates of capture are mostly in July, whereas it has been collected from April to October in the southern part of its range.

Discussion.—The above synonymy leaves the *P. serrulatae*, nec Dunning, of Bohart and Grissell (1975) without a name. It is a member of the *pacificus* group, as defined by Bohart and Grissell (1975), and is described herewith.

***Philanthus boharti* Ferguson, NEW SPECIES**

Philanthus politus serrulatae, Strandtmann, 1946:83 (in part).

Philanthus serrulatae, Bohart and Grissell, 1975:17; Bohart and Menke, 1976:566; Krombein, 1979:1725.

Bohart and Grissell (1975) keyed, figured and discussed this species under the name *P. serrulatae* (nec Dunning) and both sexes run to *P. serrulatae* in their key.

Diagnosis.—Both Sexes: Length 7–9 mm; inner eye margins parallel below the emargination; maximum head width 1.5 times width of face at apex of eye emargination; interocellar distance greater than ocellular distance; metapleural lamella absent; forewing costa whitish, at least at base; punctures on terga II–III about same size as scutal punctures; pale transverse band on terga IV–V biemarginate anteriorly; pale markings whitish with few tinges of yellow. *Male*: clypeal brushes whitish, separated medially by half the length of a brush; malar space about equal to width of pedicel; upper half of face below midocellus with punctures separated by 1 or 2 puncture diameters and microridges weak or obscure; vertex width at midocellus greater than half the interocular distance at widest part of clypeus; femora usually with a red tinge at juncture of black basal portion and

white apical portion. *Female*: malar space less than half the width of pedicel; area laterad of midocellus sparsely punctured; femora usually black, red and white, or all red.

Types.—Holotype ♂: CALIFORNIA, *San Diego Co.*, Borrego Springs, April 26, 1964 (G. & A. Ferguson, CAS). Paratypes: 100 ♂, 87 ♀ from CALIFORNIA, *San Diego Co.*, as follows: 3 ♂, 4 ♀, same data as holotype; 2 ♂, 3 ♀, same as holotype except April 27, April 28, April 29; 1 ♂, 1 ♀, Borrego Springs, III-30-60 (M. Wasbauer); 1 ♀, Borrego Springs, III-31-73 (C. Goodpasture); 3 ♂, Borrego Valley, sweeping alfalfa, III-26-59 (A. A. Grigarick); 59 ♂, 43 ♀, Borrego Valley, IV-11-62, IV-6-64, V-23-64, IV-11-69, IV-9-70, IV-2-73 (R. M. Bohart, C. Goodpasture, E. E. Grissell, J. E. Slansky, M. Wasbauer); 15 ♂, 9 ♀, Borrego Valley, dunes, IV-18-57, IV-20-57 (R. C. Bechtel, R. M. Bohart, J. C. Hall, H. E. Moffitt, E. I. Schlinger); 8 ♂, 9 ♀, Borrego Valley, Coyote Creek, III-26-59, IV-5-63 (R. M. Bohart, A. A. Grigarick, M. E. Irwin, F. D. Parker); 1 ♂, Borrego State Park, III-28-77 (J. Slansky, M. Wasbauer); 1 ♂, Borrego State Park, IV-17/20-69, *Acacia greggi* (R. R. Pinger); 6 ♀, Borrego State Park, IV-17/20-69 (M. S. & J. S. Wasbauer); 7 ♂, 11 ♀, Borego [sic], IV-1-53, IV-25-54, IV-27-54, IV-29-54, IV-24-55, IV-26-55, IV-27-55 (P. D. Hurd, M. Wasbauer). [AZS, UCB, UCD, CAS, CDA, UID, LAM, OSU, USNM, USU].

Other specimens examined.—131 ♂, 121 ♀ in addition to the type series. [AZS, UCB, UCD, CAS, CDA, UID, LAM, OSU, USNM, USU].

Distribution. Mostly in Lower Sonoran deserts from San Diego and Imperial Counties north to Mono County, California; Clark County, Nevada; Washington County, Utah; and Mohave and Yuma Counties, Arizona. In Mexico, it occurs in northwestern Sonora (El Golfo; Sonoita; 39 mi. n. Puerto Penasco); Baja California Norte (Bahia de los Angeles; Rosarito; Mexicali; San Felipe); and in Baja California Sur (Guerrero Negro) near the border with Baja California Norte.

Flight period. Most dates of capture are from March to May with a peak in April. A partial second brood is indicated by several October captures as follows: California: 2 ♀, San Bernardino Co., 25 mi. s. Ivanpah, X-12/13-58 [UCB]; 1 ♀ Imperial Co., 2 mi. s. Palo Verde, X-18-59 [UCB]; 1 ♂, San Diego Co., 13 mi. e. Borrego Springs, X-7-67 [AZS]. It may also be bivoltine in the Baja California peninsula as indicated by a male captured on II-24-74 (Guerrero Negro) [USU] and a female taken on VIII-5-73 (22 mi. s. Rosarito) [LAM]. A male and 2 females were collected at black light near El Golfo, Sonora, Mexico, IV-10-73 [CDA].

Etymology.—I am pleased to dedicate this species to Dr. Richard M. Bohart in recognition of his contributions to our knowledge of aculeate Hymenoptera, and especially for his helpful advice and encouragement in behalf of my current studies. Upon calling the *P. serrulatae* synonymy to his attention he suggested that I proceed to publish it.

Discussion. Among the small, finely punctured species of *Philanthus* with an anteriorly biemarginate pale band on terga IV–V, *P. boharti* closely resembles *P. psyche* and *P. serrulatae* in the *politus* group, and *P. pacificus* (= *P. arizonae* Dunning) and *P. pulcher* in the *pacificus* group. Since the metapleural lamella is sometimes quite small in *P. psyche* and *P. serrulatae*, the following comments may be helpful in separating the species. The metapleural lamella is almost always pigmented in *P. psyche*, and in these cases recognition of the structure is relatively easy.

The distinct malar space separates males of *boharti* from *pacificus* and *psyche*, but not from *pulcher* and *serrulatae*. In *pulcher* the forewing costa is reddish to brown to the base, and the interocellar distance is no greater than the ocellocular distance. In *serrulatae* the ocellocular distance is greater than the diameter of the midocellus, whereas in *boharti* the ocellocular distance and the midocellus diameter are subequal. In females the interocellar distance and ocellocular distance are subequal in *pulcher* and *serrulatae*, whereas the interocellar distance is always distinctly greater than the ocellocular distance in *boharti*, *pacificus*, and *psyche*. The metapleural lamella separates *psyche* from the other two species.

Bohart and Grissell (1975) discussed the problem of separating females of *boharti* from red-legged females of *pacificus*. The problem is further complicated by the presence of females of *boharti* without reddish markings on the femora (Old Woman Springs, San Bernadino County, California, IV-17-62; UCB). In *boharti* the tergal punctures are somewhat sparser and more irregularly spaced than in *pacificus* (see Bohart and Grissell, 1975, Figs. 25–28). Head measurements show that the eyes of *pacificus* are somewhat more swollen than in *boharti*. The ratio between least vertex width and width of face at the apices of the eye emarginations is the same for both species, but the maximum head width is 1.6 times the facial width in *pacificus* and only 1.5 times the facial width in *boharti*. There is virtually no overlap in the measurements ($n = 10$). In addition, the two species are largely allopatric with *boharti* being a Lower Sonoran species and *pacificus* an Upper Sonoran and Transition zone form.

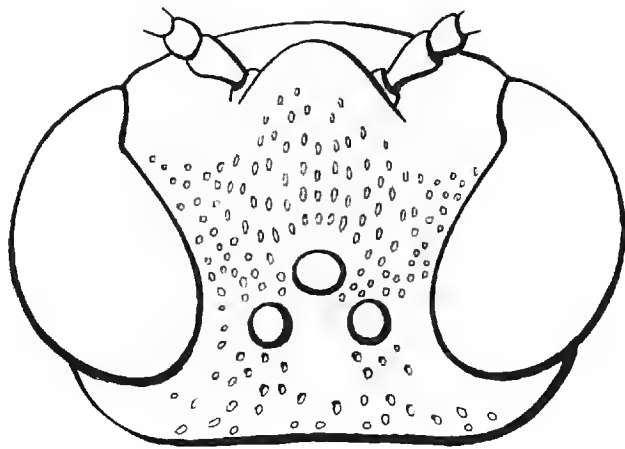
PART II. THE *PHILANTHUS POLITUS* GROUP

In this section *Philanthus parkeri* new species, belonging to the *politus* group, is described; the *politus* group is redefined to include *Philanthus ventilabris*; and a key to the *politus* group is presented.

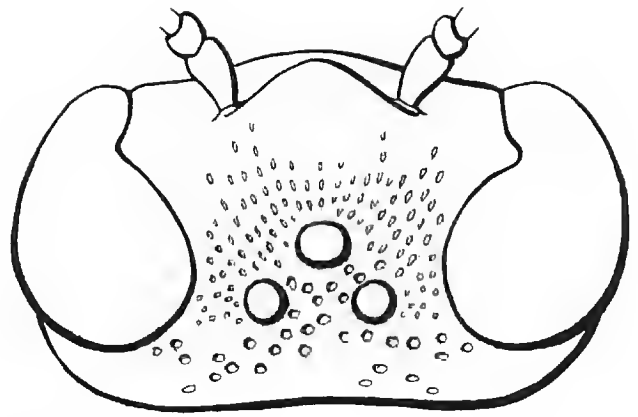
Philanthus parkeri Ferguson, NEW SPECIES

(Figs. 1, 2)

Male.—Length 5–7 mm, forewings 4–6 mm; malar space at least $\frac{3}{4}$ as long as width of pedicel; clypeal brushes whitish, separated medially by half the length of a brush; antennal sockets separated from eye margins by about 2 socket diameters and from each other by about 3 socket diameters; maximum width of head 1.5 times width of face at apex of eye emargination and 2.7 times least width of vertex; face at apex of eye emargination 1.8 times least width of vertex; ocellocular distance about equal to diameter of lateral ocellus and distinctly less than diameter of midocellus; flagellomere I about as long as combined length of scape and pedicel; interantennal groove weak to absent; upper face densely punctured with numerous microridges, sculpture continuing into area between midocellus and eye margin; ocellar triangle with few large, setigerous punctures of about the same size as those behind the ocelli; pubescence of lower face and clypeus bristly, recumbent to sub-recumbent; dense, setigerous punctures of lower face continuing onto adjacent margins of clypeus, remainder of clypeus very sparsely punctate; pronotal ridge thick, rounded; scutal punctures dense antero- and posteromedially, separated and irregular elsewhere, pit-like; scutellum sparsely punctate, groove obscure or absent; metapleural lamella prominent, pigmented; subalar carina variably pigmented, with prominent translucent lamellae laterally; propodeal en-



1



2

Figs. 1, 2. *Philanthus parkeri*, dorsal view of head. 1, male. 2, female. Actual head width 1.9 mm for male and 2.2 mm for female.

closure with large patch of punctures on each side, furrow more densely and irregularly sculptured; many punctures on tergum II smooth-rimmed and larger than scutal punctures; sterna III to V with coarse punctures mostly separated by less than 1 puncture diameter; lateral pubescence on sterna IV and V whitish, not dense; without patches of dense pubescence on sterna VI or VII.

Female.—Length 6–8 mm, forewings 5–7 mm; malar space $\frac{1}{4}$ to $\frac{1}{5}$ pedicel width; antennal sockets separated from eye margin by about 1.5 socket diameters and from each other by about 2.5 socket diameters; maximum width of head 1.6 times width of face at apex of eye emargination and 2.6 times least width of vertex; ocellocular distance 1.1 times diameter of lateral ocellus and 0.9 times diameter of midocellus; interocellar distance 1.2 times diameter of midocellus; flagellomere I longer than scape; sculpture as in male.

Coloration.—Pale markings mostly bright yellow with occasional whitish blotches; males almost entirely yellow in dorsal view, with black band across the ocellar area often present, three narrow black stripes usually indicated on scutum; median black stripe on propodeum usually present; prosternum, mesosternum and metapleural area black; legs mostly yellow except femora basally, trochanters and large spot on coxae black; tarsi yellow to reddish; wings clear hyaline, veins fulvous to reddish; narrow anterior black bands on apical terga; sterna II to V with yellow bands or large spots. Female colored much like male except that black area of vertex extends laterally down inner orbits to antennal sockets, scutum with 3 broad longitudinal black stripes, and more extensively black on propodeum. Tergum VI in female and terga VI and VII in male extensively yellow. Terga IV and V not biemarginate anteriorly.

Types.—Holotype ♂: UTAH, *Emery Co.*, 2 mi. n. Goblin Valley State Preserve, 5000 ft., Aug. 25, 1980 (A. S. Menke, F. D. Parker, Kurt A. Menke, USNM). Paratypes: 26 ♂, 67 ♀, all from *Emery Co.*, UTAH, as follows: 5 ♂, 3 ♀, same data as holotype; 8 ♂, 63 ♀, Goblin Valley, in sand dunes, IX-16-79, IX-16-80 (T. Griswold, F. D. Parker, D. Veirs); 13 ♂, 1 ♀, San Rafael Desert, Little Gilson Butte, 5000–5100 ft., VIII-19, 24-27-1980 (A. S. Menke, F. D. Parker, Kurt A. Menke) [UCD, CAS, UID, OSU, USNM, USU].

Other specimens.—27 ♂, 6 ♀, as follows: ARIZONA: *Coconino Co.*: 15 mi. n.

The Gap, IX-21-66, 1 ♀ (R. Rust, P. Torchio, G. Wood, N. Yousef, USU). IDAHO: *Butte Co.*: 7 mi. e. Howe, IX-6-67, 12 ♂ (W. F. Barr, UID). *Lincoln Co.*: 5 mi. e. Dietrich, IX-2-65, 1 ♂, 1 ♀ (R. L. Westcott, UID); 7 mi. e. Dietrich, VIII-8-69, 3 ♂ (W. F. Barr, UID). *Owyhee Co.*: Sand Dune Lake, IX-9-63, 1 ♂ (W. F. Barr and G. B. Hewitt, UID). NEBRASKA: *Sioux Co.*: Glen Canyon, VIII-25-59, 2 ♀ (W. E. LaBerge and O. W. Isacson, NEB). NEW MEXICO: *Torrance Co.*: Town of Gran Quivira, 6500 ft., VIII-20-67, 1 ♂ (H. B. Leech, CAS). Duran, VII-13-59, 3 ♂ (E. G. Linsley, UCB). UTAH: Dixie State Park, VI-13-61, 1 ♂ (G. E. Bohart, OSU). *Millard Co.*: Flowell, VIII-20-61, 1 ♀ (G. E. Bohart, OSU). *Juab Co.*: 12 mi. s. Eureka, VII-18-58, 1 ♂ (J. W. MacSwain, UCB). *Washington Co.*: 1 mi. s. Toquerville, IX-5-79, 4 ♂, 1 ♀ (J. C. and E. M. Hall, UCR).

Variation.—Most of the major collections in the western United States and several national collections have been searched for additional specimens. Thirty-three specimens were found which I am unable to separate from the type series on morphological grounds, but they differ in coloration. The specimens from outside the type locality are less maculated than the type series. Pale markings are mostly whitish with some pale yellowish blotches. The four pale spots on the scutum tend to form longitudinal stripes, narrow to moderate in width. The mesopleuron and propodeum are pale spotted but not extensively so. The pale bands on terga III to V are biemarginate anteriorly. In the female the pale band on tergum I is interrupted medially, and the band on tergum II tends to enclose black spots laterally. Terga VI and VII are immaculate in the male.

A high degree of intraspecific color variation is well known in *Philanthus* and related genera from western North America, and several other species of *Philanthus* collected in Emery County, Utah, are among the more highly maculated specimens of the respective species. I therefore conclude that the type series and the other specimens are color variants of the same species.

Distribution.—From southern Idaho to northern Arizona west of the Rocky Mountains; and western Nebraska and central New Mexico east of the Rocky Mountains.

Flight period.—The type series was collected between August 19 and September 16 with August collections composed mostly of males and September collections composed mostly of females. The specimens not included in the type series were collected between August 8 and September 21, with the exception of one male collected in June (Utah) and three males collected in July (New Mexico). The species is apparently univoltine.

Etymology.—I am pleased to name this species for Dr. Frank D. Parker who sent me the first specimens collected with the suggestion that they might represent a new species.

Discussion.—The *politus* group and the monotypic *ventilabris* group of Bohart and Grissell (1975) have a metapleural lamella which is absent in other North American species groups. Elsewhere in the Philanthidae the metapleural lamella occurs only in the genera *Clypeadon* and *Listropygia* of the subfamily Aphilanthopinae (Bohart and Menke, 1976). The *politus* and *ventilabris* groups also have short, pale clypeal brushes in the males, and the inner margins of the lower eye lobes are parallel in both sexes.

In *P. ventilabris* the transversely grooved pronotal collar and contiguous coarse tergal punctures of both sexes, and the enlarged, flattened apical flagellomere of

the male are autapomorphies, which I do not believe are sufficient in themselves to justify a group separate from the other species having a metapleural lamella.

Philanthus albopilosus Cresson was included in the *politus* group by Bohart and Grissell (1975), as it is here, but it too has certain unique characters. The thin head and wide vertex combined with an unusually wide interocellar distance are autapomorphies which serve to isolate the species from all others in the genus. The group relationship is based on the same shared characters mentioned above. In the key I have placed *P. ventilabris* and *P. albopilosus* in separate monotypic subgroups to indicate their more isolated positions.

The *politus* subgroup forms a compact, homogeneous group of five closely allied species. Of these, *P. politus*, *P. serrulatae* (= *P. siouxensis*), and *P. tarsatus* are separated from each other primarily on the basis of body sculpture and color characters, since the ocellocular proportions and head, face and vertex ratios are very similar in the three species.

P. psyche and *P. parkeri* n. sp. have a very short ocellocular distance, but they have arrived at this condition by two different routes. In males of *psyche* the maximum width of the head is 1.7 times the width of the face (measured at the apices of the eye emarginations), whereas this ratio is 1.5 in the other four species of the subgroup. The width of the face is 1.4 times the least vertex width in *psyche*—as it is in *politus* and *serrulatae*. This indicates that the higher head/face ratio in *psyche* is due to larger eyes relative to the other two species. The reduced malar space and reduced ocellocular distance in *psyche* have apparently resulted from this enlargement of the eyes.

In males of *parkeri* the head/face ratio is 1.5, as in *politus*, *serrulatae*, and *tarsatus*; but the face/vertex ratio has increased to 1.8 compared to 1.4 in *politus*, *serrulatae* and *psyche*, and 1.5 in *tarsatus*. The vertex has narrowed in *parkeri* with respect to the face, but the eyes have not perceptibly enlarged. The malar space remains, and both the interocellar and ocellocular distances have been reduced.

P. parkeri is presumed to be more closely related to *P. tarsatus* than to any other species in the subgroup because of the coarse punctures on the sterna of the two species. The denser sculpture of the upper face and ocellar area of the two species is shared with *P. politus* but not with *P. serrulatae* or *P. psyche*. In addition, the face/vertex ratio of *P. tarsatus* is 1.5, indicating a trend toward a narrowing of the vertex which reaches its culmination in the very narrow vertex of *P. parkeri*.

The narrow vertex and compact ocellocular area of *P. parkeri* are unique within the *politus* group and make it difficult to place in Bohart and Grissell's (1975) key. The following key is modified and adapted from their key to accommodate *P. parkeri*.

KEY TO SPECIES OF THE *PHILANTHUS POLITUS* GROUP

- 1. Pronotal collar thick, shallowly, transversely grooved dorsally; interocellar distance less than ocellocular distance (*ventilabris* subgroup) . . .
..... *ventilabris* Fabricius
- Pronotal collar rounded, convex; interocellar distance equal to or greater than ocellocular distance 2
- 2. Head thin in side view, not swollen behind the eyes; interocellar distance greater than distance from lateral ocellus to posterior margin of head,

- and greater than two lateral ocellus diameters (*albopilosus* subgroup)
 *albopilosus* Cresson
- Head swollen behind the eyes; interocellar distance about equal to or less than distance from lateral ocellus to posterior margin of head, and not greater than two lateral ocellus diameters (*politus* subgroup) 3
3. Males 4
- Females 8
4. Ocellocular distance about equal to lateral ocellus diameter and slightly less than midocellus diameter 5
- Ocellocular distance distinctly greater than lateral ocellus diameter and at least slightly greater than midocellus diameter 6
5. Malar space less than half the width of antennal pedicel; punctures of tergum II uniformly distributed and about same size as scutal punctures
 *psyche* Dunning
- Malar space at least $\frac{3}{4}$ the width of antennal pedicel; punctures of tergum II somewhat unevenly distributed, of uneven size, with numerous punctures smooth-rimmed and larger than scutal punctures
 *parkeri* Ferguson, new species
6. Upper face and area laterad of midocellus sparsely punctate with many large polished areas *serrulatae* Dunning
- Upper face densely punctured, interspersed with many fine ridges, sculpture extending into area laterad of midocellus 7
7. Hypoepimeron with dense, contiguous punctures and many microridges; pale band of tergum I broadly contiguous *tarsatus* H. Smith
- Hypoepimeron polished at least on anterior half, with scattered fine punctures; pale band of tergum I interrupted *politus* Say
8. Ocellocular distance about equal to diameter of midocellus; forewing costa whitish on basal half; conspicuous, recumbent, bristly pubescence on lower face between upper clypeal lobe and eye margin 9
- Ocellocular distance distinctly greater than diameter of midocellus; forewing costa reddish or brown to base; pubescence of lower face fine, not recumbent 10
9. Interocellar distance about twice the diameter of the lateral ocellus; sterna III-V sparsely, shallowly punctate; width of face at apices of eye emarginations 1.4 to 1.5 times least width of vertex *psyche* Dunning
- Interocellar distance much less than twice the diameter of lateral ocellus; sterna III-V coarsely, rather densely punctate; width of face at apices of eye emarginations 1.7 to 1.8 times least width of vertex
 *parkeri* Ferguson, new species
10. Hindtarsi black or heavily infuscated; punctures of mesopleuron, especially hypoepimeron, dense, contiguous, with numerous microridges
 *tarsatus* H. Smith
- Hindtarsi yellowish to reddish; punctures of mesopleuron well separated by thick, polished ridges and anterior part of hypoepimeron shiny with sparse punctures 11
11. Hindfemora red, or black and red; scutal punctures sparse and irregular with numerous large polished areas *serrulatae* Dunning
- Hindfemora black and yellow; scutal punctures dense and evenly spaced at least over anterior $\frac{1}{3}$ of scutum *politus* Say

ACKNOWLEDGMENTS

I am indebted to the following individuals and institutions for the loan of specimens used in this study (abbreviations as used in the text are in brackets): D. Otte, Academy of Natural Sciences of Philadelphia [ANSP]; F. F. Hasbrouk, Arizona State University, Tempe [AZS]; J. A. Powell, University of California, Berkeley [UCB]; R. M. Bohart, R. O. Schuster, University of California, Davis [UCD]; S. I. Frommer, University of California, Riverside [UCR]; W. J. Pulawski, California Academy of Sciences, San Francisco [CAS]; M. S. Wasbauer, California Department of Food and Agriculture, Sacramento [CDA]; W. F. Barr, University of Idaho, Moscow [UID]; R. R. Snelling, Los Angeles County Museum of Natural History, Los Angeles [LAM]; B. C. Ratcliffe, University of Nebraska State Museum, Lincoln [NEB]; J. D. Lattin, Oregon State University, Corvallis [OSU]; A. S. Menke, Systematic Entomology Laboratory, USDA, % United States National Museum of Natural History, Washington, D.C. [USNM]; F. D. Parker, Utah State University, Logan [USU].

I thank Bonnie T. Hall, Systematic Entomology Laboratory, Oregon State University, for preparation of the illustrations.

LITERATURE CITED

- Bohart, R. M., and E. E. Grissell. 1975. California wasps of the subfamily Philanthinae. *Bull. Calif. Insect Survey* 19:1-92.
- Bohart, R. M., and A. S. Menke. 1976. Sphecids wasps of the world. A generic revision. University of California Press, Berkeley and Los Angeles, ix + 695 pp.
- Dunning, S. N. 1898. Notes on *Philanthus*. *Can. Ent.* 30:152-155.
- Krombein, K. V. 1979. Sphecoidea, pp. 1573-1740. *In* K. V. Krombein, Paul D. Hurd, Jr., David R. Smith, and B. D. Burks, *Catalog of Hymenoptera in America north of Mexico*. v. 2:1199-2209. Smithsonian Inst. Press, Washington, D.C.
- Mickel, C. E. 1916. New species of Hymenoptera of the superfamily Sphecoidea. *Trans. Amer. Ent. Soc.* 42:399-434.
- Strandtmann, R. W. 1946. A review of the North American species of *Philanthus* north of Mexico. Ohio State Univ. Press, Columbus, 126 pp.

Heterotardigrada of Venezuela (Tardigrada)

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About 100 species of tardigrades are known from South America from the countries of Argentina, Bolivia, Brazil, Chile, Columbia, and Paraguay (Ramazzotti, 1972). In 1979 tardigrades were collected primarily in mosses and lichens from 10 sites in the northwestern section of Venezuela. The area collected represents only one-third of the country but over 20 species were identified in the class Eutardigrada and 14 in the Heterotardigrada. Only Brazil shows a larger species representation in the literature.

The Heterotardigrada found in Venezuela includes species in *Oreella*, *Mopsechiniscus*, *Bryodelphax*, *Echiniscus*, and *Pseudechiniscus*. Of the 14 species, five are new—one species each of *Oreella* and *Bryodelphax*, and three species of *Echiniscus* in the arctomys complex. Holotypes are deposited at the University of California, Davis, and voucher specimens at the University of Zulia, Maracaibo.

MATERIALS AND METHODS

Mosses, lichens, and liverworts were removed from various plant and mineral substrates, placed in paper bags, and air dried—at times with artificial heat. Specimens were processed in the United States and prepared for light microscopy and scanning electron microscopy as indicated in Horning, Schuster and Grigarick (1978). One or more species of Heterotardigrada were collected from the following sites:

- El Tucuco, Zulia. VI-24-79. Tropical forest in foothills of Sierra De Perija, bordering a grassland biome, alt. 700 m, precipitation 2000 mm.
- La Carbonera, Merida. VI-30-79. Subtropical cloud forest in Sierra Nevada range of Andes, alt. 2000 m, precipitation 1800 mm.
- Merida, Merida. VII-3-79. Sierra Nevada range of Andes, alt. 1627 m, precipitation 1800 mm.
- La Mucuy, Merida. VII-4-79. Sierra De St. Domingo range of Andes, alt. 1800 m, precipitation 1800 mm.
- Barrancas, Barinas. VII-6-79. Foothills of Sierra De St. Domingo range and edge of Llanos Planes, alt. 200 m, precipitation 1280 mm.
- Yacambu, Lara. VII-9-79. Subtropical rainforest, alt. 1500 m, precipitation 1300 mm.
- Rancho Grande, Aragua. VII-14-79. Tropical rainforest, alt. 1130 m, precipitation 1720 mm.

Tardigrades in the class Heterogardigrada are recognized by the presence of a lateral clava and cirrus between the head and scapular segments. Both families, Echiniscidae and Oreellidae, of the Order Echiniscoidea occur in Venezuela.

The Echiniscidae typically have five transverse segments, designated by letters A through E, also referred to as the head (A), scapular (B) and terminal (E) segments. Median plates are numbered from anterior to posterior. Lateral spines occur at the post-lateral angles of the transverse segments and bear the same letter. Dorsal spines are identified by the segment letter and superscript "d." *Pseud-echiniscus* has an additional segment (pseudosegmental plate) between segments D and E. The following keys will distinguish the taxa found in this study.

KEY TO FAMILIES AND GENERA

1. Dorsum without distinct plates Oreellidae—*Oreella*
- Dorsum with distinct plates Echiniscidae—2
2. Head without buccal cirri *Mopsechiniscus*
- Head with buccal cirri 3
3. Pseudosegmental plate present *Pseudechiniscus*
- Pseudosegmental plate absent 4
4. Median plates 1 and 2 transversely divided *Bryodelphax*
- Median plates 1 and 2 not divided *Echiniscus*

KEY TO *PSEUDECHINISCUS*

1. Posterior margin of pseudosegmental plate with two spines or lobes; granulation large (0.7–1.25 μm); cuticle without pores *P. novaezeelandiae* (Richters)
- Posterior margin of pseudosegmental plate without spines or lobes; granulation small (0.5–0.8 μm); cuticle with pores ... *P. suillus facettalis* Peterson

KEY TO *ECHINISCUS*

1. Lateral spines present only on plate A (cirrus A) 2
- Lateral spines present on plate A and one or more other plates 6
2. Cuticle not green 3
- Cuticle green 5
3. Cuticle of dorsal plates consists of pores (light spots) and granules (dark spots); spines smooth 4
- Cuticle of dorsal plates consists of pores only; E spines barbed dorsally and sometimes ventrally *E. angolensis* da Cunha and Ribeiro
4. Some dorsal or lateral spines as long as spine E; legs II and III without minute spine *E. virginicus* Riggin
- Dorsal and/or lateral spines shorter than spine E; legs II and III with minute spines *E. perarmatus* Murray
5. Cuticle of dorsal plates with pores *E. viridissimus* Péterfi
- Cuticle of dorsal plates without pores *E. viridus* Murray
6. Cuticle of dorsal plates with pores (light spots only) 7
- Cuticle of dorsal plates with pores (light spots) and granules (dark spots) 8
7. Scapular and terminal plates with longitudinal and transverse bands lacking pores *E. kofordi* Schuster and Grigarick
- Scapular and terminal plates without such bands *E. mosaicus* Grigarick, Schuster, and Nelson, n. sp.
8. Cuticle of dorsal plates with regularly distributed pores; anterior margins

- of plates C and D with pores
..... *E. aliquantillus* Grigarick, Schuster, and Nelson, n. sp.
- Cuticle of dorsal plates with irregularly distributed pores; anterior margins
of plates C and D without pores
..... *E. marginoporus* Grigarick, Schuster, and Nelson, n. sp.

Genus *Oreella* Murray, 1910

The genus *Oreella* is in the family Oreellidae. It is distinguished from the other genera in the family, which are aquatic, by its indistinctly eight-segmented body lacking dorsal plates and by the presence of a short median caudal projection. According to the diagnostic characters of the genus (Ramazzotti, 1972:136), the claws are not spurred; however, the inner claws of the New Zealand specimens (Horning *et al.*, 1978) of *Oreella minor* Ramazzotti do have spurs, as does the single specimen of *Oreella* from Venezuela.

Oreella breviclava Grigarick, Schuster, and Nelson, NEW SPECIES
(Figs. 1, 2)

Holotype female.—Length excluding legs IV, 174 μm ; including legs IV, 191 μm ; width, 81 μm . No eyes. Cuticle colorless, with very fine granulation over entire surface; small hemisphericle tubercles visible along margins of cuticle, present on dorsal and lateral cuticle; short, median, conical, caudal papilla between legs IV. Head with acuminate buccal cirri; internal cirrus 10 μm long; external cirrus, 14 μm long; buccal papilla 5.7 μm long by 2 μm wide. Cirrus A, 19 μm long; clava short, 5 μm long by 2 μm wide. Leg I apparently without spine; papilla on leg IV 2 μm long by 1 μm wide; without dentate fringe on legs IV. Strong spurs on internal claws of all legs; claws 10 μm long.

Etymology.—Latin: *brevi*, short; *clava*, for the short clava.

Discussion.—A single specimen was collected from one locality in Venezuela. It is very similar to *Oreella minor* but differs in the following respects: relative lengths of the internal and external cirri, the presence of buccal papillae, claw length, the absence of a spine on leg I, and the length of the clava. The internal cirrus is half the length of the external in *O. minor*, but greater than half the length ($\frac{2}{3}$) in the Venezuelan specimen. In his illustration of *O. minor* from Chile, Ramazzotti (1964) omitted the buccal papillae because he was unable to detect them on the eight specimens he studied; our specimen has distinct buccal papillae. The claws of *O. minor* are smaller (3–4 μm) than those of our specimen (10 μm). An obvious spine is present on leg I of *O. minor*; no such spine is apparent on our specimen. Ramazzotti (1972) suggested that specimens with long, more or less curved clavae (11–18 μm) are probably males of *O. minor*, while those with short straight clavae (3.5–5 μm) are females, corresponding to the hypothesis for *Halechiniscus* proposed by Richters (1909) and Schulz (1955). The specimen from Venezuela is a female based on the structure of the gonopore, and therefore may actually be *O. minor* if Ramazzotti’s hypothesis is correct.

Another species, *Oreella vilucensis* Rahm, was described from Chile. This species is characterized by the presence of two lateral conical spines and the absence of clavae, which, if correct, would be unique in the Echiniscoidea.

A third species, *Oreella mollis* Murray, is a larger species that has a long thin

clava, very long cirri A, no fine granulation (although it may have been overlooked), marked body segmentation, and internal claws without spurs.

Distribution.—Holotype, La Carbonera, 1 specimen.

Genus *Mopsechiniscus* du Bois-Reymond Marcus, 1944

The genus *Mopsechiniscus* in the family Echiniscidae is characterized by the absence of the buccal cirri and the presence of two lateral oval cephalic structures and a small median process dorsal to the buccal aperture. Two species have been reported from South America: *Mopsechiniscus imberbis* (Richters) from Chile and Brazil; *Mopsechiniscus granulosus* Mihelčič from the Andes in Argentina.

***Mopsechiniscus imberbis* (Richters), 1907**

(Figs. 3-5)

Our specimens illustrate a wide range of variability in the presence and lengths of the spines and filaments. Ramazzotti (1972) reported variations found in three populations of *M. imberbis*, from South Georgia, Brazil and Chile. The South Georgia specimens have lateral C spines and D filaments; the Brazilian, with C spines only (sometimes missing); and the Chilean, with lateral C and D filaments and sometimes small B spines. Our specimens have a combination of no spines; lateral spines at D only or C and D; short lateral spines at C and D and a strong spine at the posterior margin of the pseudosegmental plate; or strong or short spines only on the pseudosegmental plate. A single larva has dorsal spines at the posterior margins of median plates 1 and 2 and the pseudosegmental plate. In general, the number and length of the spines decrease with an increase in the body length of the animal. The opposite situation occurs in other armored tardigrades such as *Echiniscus* and *Pseudechiniscus*. Our specimens also have spurs at the base of the inner claws on all legs, but they are much less developed on legs I-III. The cuticle is ornamented with irregular-sized raised dark granules.

The cuticle of *Mopsechiniscus granulosus* is ornamented, according to Mihelčič (1967), *inside* the cuticle itself, not on the surface. There are short B spines, long lateral C and D filaments, and the caudal margin of the pseudosegmental plate has two lobes bearing a distal spine.

Distribution.—La Carbonera, 5 specimens; Merida, 1.

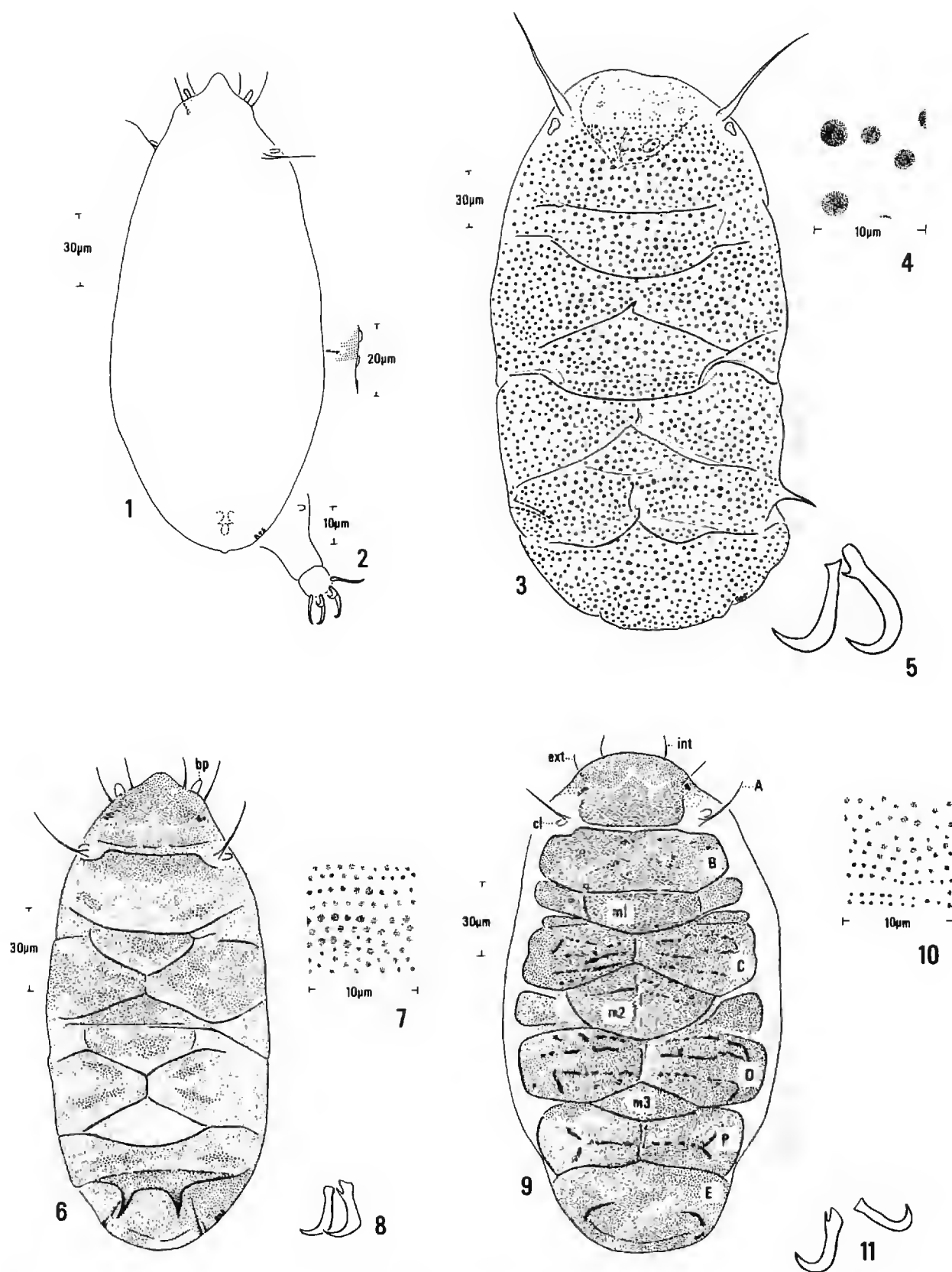
Genus *Pseudechiniscus* Thulin, 1911

The genus *Pseudechiniscus* in the family Echiniscidae is characterized by the presence of a transverse pseudosegmental plate between the second paired plates (D) and the terminal plate. Six species have been reported from South America from Chile, Bolivia, Argentina, Brazil, and Columbia. The two species collected in Venezuela were recovered from samples at four of the seven areas heterotardigrades were found. Most of the collections were made in the higher mountainous areas of the Andes.

***Pseudechiniscus novaezeelandiae* (Richters), 1908**

(Figs. 6-8)

Our specimens agree with the description in Ramazzotti's monograph (1972), and with specimens from New Zealand in our collection. The cuticular granulation



Figs. 1–11. 1, 2. *Oreella breviclava*. 1, dorsal aspect; 2, detail of legs and claws IV. 3–5. *Mops-echiniscus imberbis*. 3, dorsal aspect; 4, cuticle of scapular plate; 5, exterior and interior claws leg IV. 6–8. *Pseudechiniscus novaezeelandiae*. 6, dorsal aspect; 7, cuticle of scapular plate; 8, exterior and interior claws leg IV. 9–11. *Pseudechiniscus suillus facettalis*. 9, dorsal aspect; 10, cuticle of scapular plate; 11, exterior and interior claws leg IV.

is coarser than on *Pseudechiniscus s. facettalis*. The granules are larger on the interior margin of the scapular plate, median plates 1 and 2 and the anterior halves of the paired plates. Two spines, variable in size, are usually, but not always, present on the posterior margin of the pseudosegmental plate. A thin basal spur is present on the inner claw of all legs.

Discussion.—*Pseudechiniscus n. novaezeelandiae* has been previously reported

in South America from Brazil, Columbia and Argentina. It is difficult to distinguish from the subspecies *P. n. marinae* Barros and *P. pseudoconifer* Ramazzotti and according to Ramazzotti (1972), the specimens from Brazil identified as *P. n. marinae* by Barros were probably *P. pseudoconifer*. The cuticular granule size and absence of cuticular pores are useful in separating *P. n. novaezeelandiae* from *P. s. facettalis*.

Distribution.—La Mucuy, 26 specimens; Merida, 13; Barrancas, 1; La Carbonera, 5.

***Pseudechiniscus suillus facettalis* Petersen, 1951**

(Figs. 9-11)

Our specimens agree with the description in Ramazzotti's monograph (1972). The terminal plate is faceted, and there is a tiny spur at the base of the inner claws on all legs. The cuticle has a fine granulation with ridged areas of thickened cuticle; a few pores are scattered irregularly in the cuticle.

Discussion.—The *suillus* group includes *Pseudechiniscus suillus facettalis* Petersen and *Pseudechiniscus suillus franciscae* Barros. The nominate subspecies is known from five South American countries. The subspecies *P. s. facettalis* has been reported from Tierra del Fuego (Ramazzotti, 1972). Originally described from Brazil, *P. s. franciscae* differs from our specimens by the presence of smooth cuticle between the plates and the absence of spurs on all claws. A similar species, *Pseudechiniscus juanita* Barros, also described from Brazil, has "large" granules, especially on the pseudosegmental plate and the terminal plate (Barros, 1939).

Distribution.—La Mucuy, 31 specimens; Merida, 39; Barrancas, 1; La Carbonera, 6.

Genus *Bryodelphax* Thulin, 1928

The genus *Bryodelphax* is in the family Echiniscidae. *Bryodelphax* is distinguished from other genera in the family by the transverse division of the first and second median plates with the third median plate undivided and highly developed; in addition, the terminal plate lacks the two notches along the posterior margin.

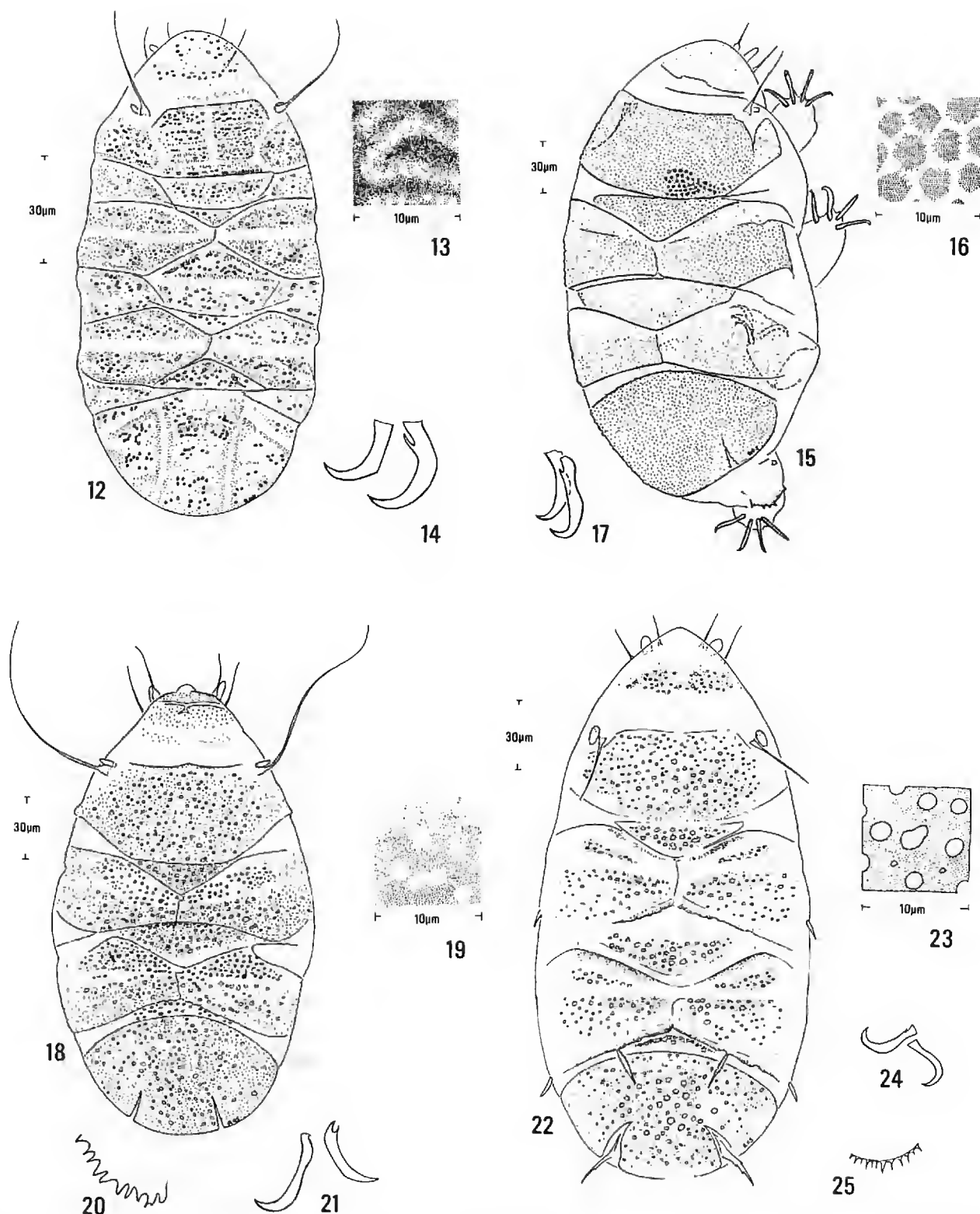
***Bryodelphax crossotus* Grigarick, Schuster, and Nelson, NEW SPECIES**

(Figs. 12-14)

Holotype female.—Length excluding legs IV, 135 μm . Cuticle colorless, with granulation and pores on all plates, forming indistinct ridges on scapular and terminal plates. Median plates 1 and 2 divided, median plate 3 undivided, triangular in shape. Head with acuminate buccal cirri internal cirrus 5 μm long, external cirrus, 10 μm long; buccal papilla 2 μm long by 1.9 μm wide. Cirrus A, 30 μm long; clava, 2.5 μm long by 1.9 μm wide. No apparent spine on leg I; papilla on leg IV, 4.8 μm long by 2.8 μm wide; non-dentate fringe on leg IV, thickened irregular, almost scalloped edge, granulate above. Claws 8 μm long; inner claws with spurs at base on all legs; all legs microgranulate.

Etymology.—Greek: *krossotus*, fringed, for the non-dentate fringe on legs IV.

Discussion.—*Bryodelphax ortholineatus* Bartos, *B. parvulus* Thulin and *B. dominicanus* Schuster & Toftner are species from South or Central America that have the dorsal collar of leg IV with a smooth distal margin. This margin is somewhat irregular on *B. crossotus* but not dentate. The cuticles of *ortholineatus*



Figs. 12–25. 12–14. *Bryodelphax crossotus*. 12, dorsal aspect; 13, cuticle of scapular plate; 14, claws of leg IV. 15–17. *Echiniscus viridis*. 15, dorsal aspect; 16, cuticle of scapular plate; 17, claws leg IV. 18–21. *Echiniscus viridissimus*. 18, dorsal aspect; 19, cuticle of scapular plate; 20, dorsal denticles leg IV; 21, claws leg IV. 22–25. *Echiniscus augolensis*. 22, dorsal aspect; 23, cuticle of scapular plate; 24, claws leg IV; 25, dorsal denticles leg IV.

and *parvulus* and the shape of the median plates are different from *crossotus*. This species is similar to *dominicanus* but the cuticle does not have the large depressions (fossae) of *dominicanus*.

Distribution.—Holotype, Rancho Grande; paratypes: El Tucuco, 13 specimens; Rancho Grande, 1.

Genus *Echiniscus* C. A. S. Schultze, 1840

The genus *Echiniscus* is in the family Echiniscidae Thulin, 1928. *Echiniscus* is distinguished from the other genera by undivided median plates 1, 2, and 3, and

by the presence of notches along the posterior margin of the terminal plate. In Ramazzotti's key (1972), species of *Echiniscus* are grouped according to Marcus: the groups *arctomys*, *spinulosus*, *scrofa*, *blumi*, *trisetosus*, and *biunguis*. The *arctomys* group consists of the species of *Echiniscus* that have no lateral appendages other than cirrus A, although dorsal appendages may be present. The other groups are distinguished by the number and type (spine, filament) of lateral appendages. Nine species of *Echiniscus* were collected in Venezuela, three of which are new species in the *arctomys* group.

***Echiniscus viridis* Murray, 1910**

(Figs. 15-17)

Our specimen fits the description in Ramazzotti's monograph (1972). Cirrus A is 38 μm long. The cuticle is green and ornamented with clusters of small dark green granules which form slight tubercles which appear as dark spots. A minute basal spur is present on the inner claws of all legs. The dentate fringe has short uneven spines with very irregular spacing in between the spines; the arrangement of these dorsal leg spines is very distinctive and unique in the species complex.

Discussion.—*Echiniscus viridis*, known from Brazil, is one of four described species in the *viridis* complex. The complex consists of green *Echiniscus* with no lateral or dorsal appendages other than cirrus A. *Echiniscus perviridis* Ramazzotti has a pattern of raised granules similar to that of *E. viridis*; however cirri A are up to 150–170 μm long. *Echiniscus rufoviridis* Bois-Reymond Marcus, described from Brazil, is green caudally only, with short cirri A (30–40 μm). The cuticular pattern of *Echiniscus viridissimus* Péterfi consists of both pores and dark raised granules. The cuticle of *E. viridis* is pigmented in areas indicated by denser stippling (Fig. 15) and the dorsal plates, except for the head, show a rather uniform pattern of discrete granules.

Distribution.—Rancho Grande, 1 specimen.

***Echiniscus viridissimus* Péterfi, 1956**

(Figs. 18-21)

Our specimens fit the description of Ramazzotti's monograph and agree with determined specimens in the collections at ETSU and UCD. Cirrus A is 75 μm long. The cuticle is green and ornamented with a very fine regular granulation. The scapular and terminal plates have pores, which appear as light spots. The paired plates have an anterior zone of dark granules which appear separated from the posterior zone by a transverse stripe.

Discussion.—The dorsal plating of this species is greenish in the same areas as *E. viridis*. Whereas the cuticular pattern of the dorsal plates of *E. viridis* consists of discrete granules, that of *E. viridissimus* is predominantly of pores (light spots) except for a minutely granular head and granules on the anterior of plate pairs C and D and on the area between plates D and the terminal plate.

Distribution.—Rancho Grande, 11 specimens.

***Echiniscus angolensis* da Cunha and Ribeiro, 1964**

(Figs. 22-25)

Body length excluding legs IV, 225 μm . Cuticle with pores only, slightly larger on median plates. Cephalic plate with rostral zone of pores. Cirrus A, 29 μm long.

Short C, D spines (5–6 μm); robust D^{d} spine, 17 μm , may have rough or spiny appearance; robust, rough (spiny) E spine, 16 μm . Terminal plate with distinct notches. Dentate fringe on legs IV with 16–17 slender, sharp, short teeth. Very slender spur on internal claws of all legs.

Discussion.—The distinction between *Echiniscus angolensis* from West Africa and *Echiniscus crassispinosus fasciatus* Marcus from Brazil and East Africa is difficult. Based on the illustrations in Ramazzotti's monograph (1972), the Venezuelan specimens more closely resemble *E. angolensis*, although there are some discrepancies not yet resolved. The description of *E. angolensis* does not mention the presence of the C spine, yet it is clearly illustrated in their drawing; the C^{d} spine which is mentioned is very small or missing on the illustration.

We have not seen the type of either species and have elected to use the name *E. angolensis* at this time.

Distribution.—Merida, 4 specimens.

***Echiniscus virginicus* Riggin, 1962**

(Figs. 26–29)

Cuticle with characteristic ornamentation of pores and granules. Area of median plate 3 also ornamented. Posterior margins of paired plates minutely scalloped. The dorsal and lateral spines are variable, both in occurrence and development. Lateral spine B is sometimes absent on one or both sides; C, D, E are present. Dorsal spines C^{d} and D^{d} are of variable length and rarely absent; the spines may be the same length or either may be considerably shorter than the other. Spur present at base of internal claws of all legs. Leg I with spine and leg IV with large papilla. Dentate fringe with 8–10 teeth.

Discussion.—The Venezuelan specimens agree with Riggin's holotype deposited in the Smithsonian Institution and with other specimens from Florida and Tennessee. The cuticular ornamentation differs from that of *Echiniscus quadrispinosus brachyspinosus* Bartos, which Ramazzotti considered the same as *E. virginicus*.

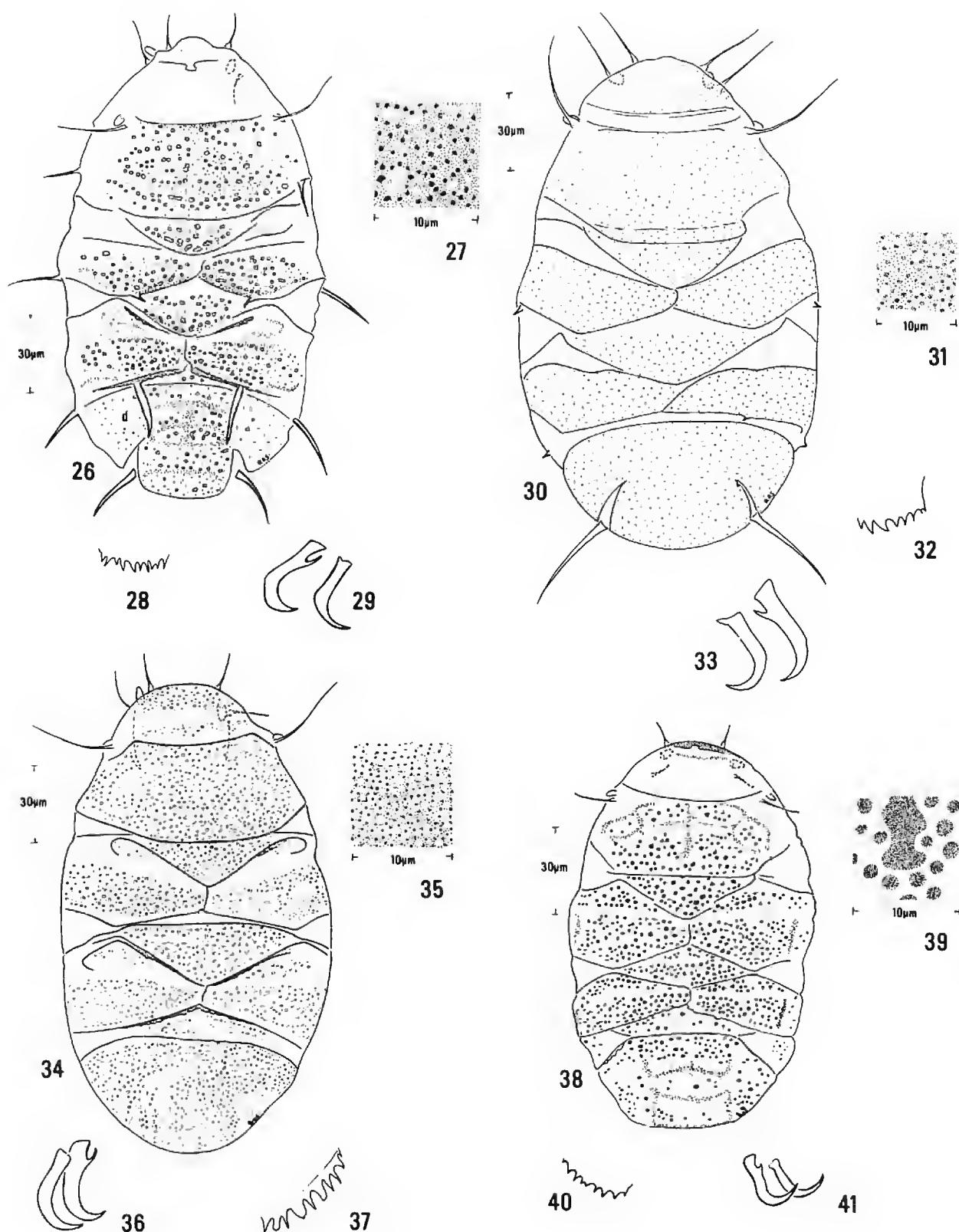
Distribution.—La Carbonera, 9 specimens; La Mucuy, 15; Merida, 19; Barrancas, 4; El Tucuco, 1; Yacambu, 5; Rancho Grande, 2. *Echiniscus virginicus* was the most widely distributed heterotardigrade and was only surpassed by *Pseud-echiniscus suillus facettalis* in numbers collected.

***Echiniscus perarmatus* Murray, 1907**

(Figs. 30–33)

The Venezuelan specimens agree with the description in Ramazzotti's monograph (1972). The cuticle is ornamented with a very fine uniform granulation, larger regularly distributed granules, and a few light pores. Each pore appears bordered by four of the larger granules. Although pores are not mentioned in the original description, they are present as surface structures. Short C, D teeth are present and occasionally very short D^{d} spines. The E spines are curved and as long or longer than cirrus A. A distinguishing character is the presence of a short thorn-like papilla on legs I–III; legs II and III should be observed carefully.

Discussion.—The species was described from South Africa and another report from Hawaii is uncertain. Dr. Deidre Christenberry has collected *E. perarmatus* from the Southeastern United States. Her specimens, deposited at the Smithsonian Institution, agree closely with ours.



Figs. 26-41. 26-29. *Echiniscus virginicus*. 26, dorsal aspect; 27, cuticle of scapular plate; 28, dorsal denticles of leg IV; 29, internal and external claws leg IV. 30-33. *Echiniscus perarmatus*. 30, dorsal aspect; 31, cuticle of scapular plate; 32, dorsal denticles of leg IV; 33, internal and external claws leg IV. 34-37. *Echiniscus aliquantillus*. 34, dorsal aspect; 35, cuticle of scapular plate; 36, internal and external claws leg IV; 37, dorsal denticles leg IV. 38-41. *Echiniscus kofordi*. 38, dorsal aspect; 39, cuticle of scapular plate; 40, dorsal denticles of leg IV; 41, internal and external claws leg IV.

Distribution.—Yacambu, 10 specimens.

***Echiniscus aliquantillus* Grigarick, Schuster, and Nelson, NEW SPECIES**
(Figs. 34-37)

Holotype female.—Length excluding legs IV, 185 μ m. Cuticle colorless; all plates with very fine regular granulation and random distribution of small but distinct pores. Cephalic plate with rostral zone of pores and granules and posterior band

of very fine granulation and very small pores. Pattern of granulation and pores similar on median plates 1 and 2; median plate 3 absent or not well-defined but the area between the paired plates and the terminal plate has the same cuticular pattern as the other median plates. Paired plates have clear zone separating the anterior (with few pores) from the posterior part. Granulation and pores extend onto legs. Posterior margin of median plate 2 and paired plates D is scalloped. Head with acuminate buccal cirri; internal cirrus 14 μm long; external cirrus, 16 μm long; buccal papilla, 7 μm long by 3 μm wide. Cirrus A, 34 μm long; clava, 7.6 μm long by 2.4 μm wide, longer and thinner than buccal papilla. Slender spine on leg I; papilla on leg IV 5 μm long by 2 μm wide. Dentate fringe on leg IV with 10–12 short sharp spines; area above fringe with pores and granules. Spurs on internal claws of all legs, very distinct and well-developed on legs IV; claws 12 μm .

Etymology.—Latin: *aliquantillus*, very small; named for the numerous small pores.

Discussion.—Several species in the arctomys group are very similar but can be distinguished by their cuticular patterns. Previously named species differ from the Venezuelan specimens in the following ways. *Echiniscus arctomys* Ehrenberg and *Echiniscus wendti* Richters, both reported from South America, have granulations but no pores; both have longer cirri A, especially *E. wendti* which has a cirrus A length up to 55–70% of the body length. *Echiniscus phocae* Bois-Reymond Marcus, described from Brazil, has a characteristic ornamentation consisting of circular groups of small granules. Mihelčič (1967) described several similar species from Argentina, including *Echiniscus bellus*, *insuetus*, *roseus*, and *speciosus*; these species are practically indistinguishable on the basis of their descriptions, and slides identified and labeled by Mihelčič do not correspond to each other or the descriptions. All have cirrus A much longer than in the Venezuelan specimens.

The cuticular pattern of *Echiniscus kerguelensis* Richters, reported from Australia and SW Africa at 1600–2000 m and other localities, most clearly resembles that of the Venezuelan specimens. The description in Ramazzotti (1972), however, is unclear and may represent a combination of two or more species. For example, the ornamentation can appear granulated or porous; the two paired plates have, or do not have, a smooth unornamented transverse stripe; lateral cirrus A is 50–80 μm ; claws, 18 μm long. The Venezuelan specimens have very fine granulation and pores, an unornamented stripe on the paired plates, shorter cirrus A, and shorter claws.

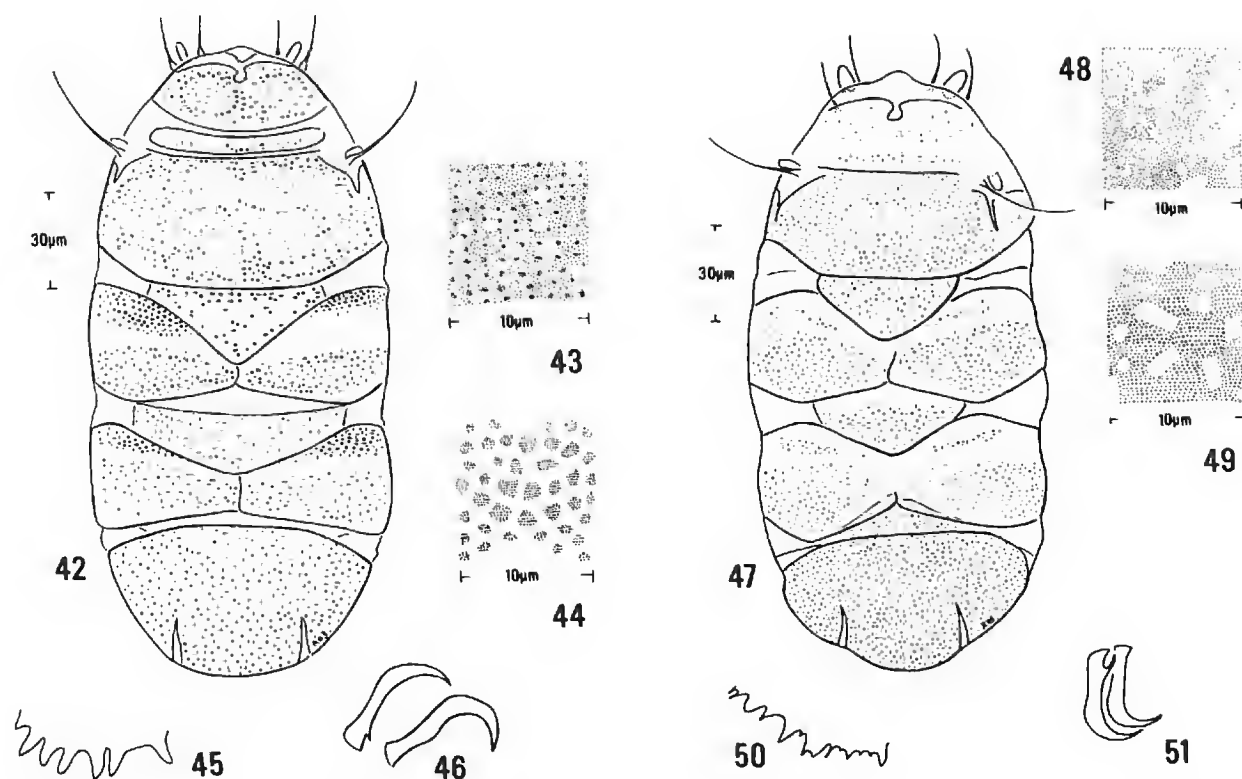
Distribution.—Holotype, La Carbonera; paratypes: La Carbonera, 36 specimens; Merida, 4.

Echiniscus kofordi Schuster and Grigarick, 1966

(Figs. 38–41)

This species has only lateral cirrus A. The dorsal plates are granular with distinctive patterns (fine stipple on Fig. 38) on the head, scapular and terminal plates, and lateral margins of C and D.

Discussion.—This species is related to *E. tessellatus* J. Murray but differs by having a shorter spine A and by the divisions of the scapular and terminal plates. The single specimen compared favorably with the type from the Galápagos Islands.



Figs. 42-51. 42-46. *Echiniscus marginoporus*. 42, dorsal aspect; 43, cuticle of scapular plate; 44, cuticle of anterior margins of plates C and D; 45, dorsal denticles of leg IV; 46, internal and external claws leg IV. 47-51. *Echiniscus mosaicus*. 47, dorsal aspect; 48, 49, variation in pores of cuticle of scapular plate; 50, dorsal denticles of leg IV; 51, internal and external claws leg IV.

Distribution.—El Tucuco, 1 specimen.

***Echiniscus marginoporus* Grigarick, Schuster, and Nelson, NEW SPECIES**
(Figs. 42-46)

Holotype female.—Length excluding legs IV, 200 μm . Cuticle colorless; cuticular pattern consists of granulation and pores. Cephalic plate consists of a rostral zone with regular granulation and a few small pores, separated by a clear zone from a posterior band of granules and pores. Scapular plate with regular granulation and marginal pores (Fig. 43), especially on posterior part, and irregular median row of pores. Anterior portion of plates C and D with irregular shaped granules only (no pores) and posterior portion with granules and marginal pores, especially along posterior margin. Paired plates entirely granulated, no unornamented stripe present. Median plates 1 and 2 with regular granules and pores; median 3 absent but area between D and E plates with granules. Terminal plates with granules and scattered small pores. Head with internal acuminate buccal cirrus 12 μm ; external cirrus, 18 μm ; buccal papilla 6.6 μm long by 2.8 μm wide. Spine on leg I a small thorn; papilla on leg IV present. Dentate fringe on leg IV with 7-8 well-defined large sharp teeth; area above fringe granulated. Dorsal surface of all legs granulate; internal claws of all legs with spurs, internal claws, 16 μm ; external claws, 14 μm .

Etymology.—Latin: *marginoporus* was named for the marginal pores on the plates.

Discussion.—The Venezuelan specimens are in the arctomys group, but the cuticular pattern differs from all other described species. See also the discussion of *Echiniscus aliquantillus* n. sp.

Distribution. — Holotype, La Mucuy; paratypes: La Mucuy, 2 specimens; Rancho Grande, 1; Barrancas, 2.

***Echiniscus mosaicus* Grigarick, Schuster, and Nelson, NEW SPECIES**
(Figs. 47–51)

Holotype female. — Length excluding legs IV, 190 μm ; including legs IV, 218 μm . Cuticle colorless. Cephalic plate with small pores and granules on rostral zone of head. Scapular plate with large pores 1–2.8 μm , and large black granules 2–3 μm ; 4–6 pores surround granule, larger on posterior margin (Figs. 48–49). Paired plates with clear (unornamented) transverse stripe that separates smaller anterior part from posterior portion of plate. Median plates 1 and 2 with pattern similar to posterior margin of scapular plate. Median 3 small but area has pattern similar to other median plates. Terminal plate with pronounced pores. Interpore area triangular or hexagonal. Cuticular pattern forms a mosaic appearance; hexagonal pattern is more apparent in some areas where pore size is smaller. Interpore areas are joined, forming a reticulate pattern. Slight lateral hemispherical pouch may be seen on some specimens between legs II and III and between legs III and IV. Head with acuminate buccal cirri, internal cirrus, 15 μm long; external cirrus, 19 μm long; buccal papilla prominent, 9.5 μm long by 5.7 μm wide, larger than clava. Cirrus A, 33 μm ; clava, 7.6 μm long by 3.8 μm wide. Spine on leg I a short thorn; papilla on leg IV 3.8 μm long by 2 μm wide. Dentate fringe on leg IV with 10–12 sharp spines of irregular size. Spurs on internal claws of all legs; internal claws, 14 μm ; external claws, 13 μm .

Etymology. — Latin: *mosaicus*, mosaic; named for the mosaic cuticular pattern.

Discussion. — The cuticular pattern of *E. mosaicus* somewhat resembles that of *Echiniscus elegans* Richters and *Echiniscus reticulatus* Murray, and is reminiscent of the gameboard for Chinese checkers. The smaller sized cuticular pattern and transverse clear stripes on the paired plates of *E. mosaicus* readily distinguish it from these species.

Distribution. — Holotype, La Carbonera; paratype, Merida, 1 specimen.

ACKNOWLEDGMENTS

We wish to thank Dr. Richard Bohart for partially financing and initiating the arrangements that led to the collections of tardigrades reported in this paper. The arrangements were made with Dr. Edmundo Rubio, the Dean of the Faculty of Agronomy of the University of Zulia and formerly a student of Dr. Bohart. Financing and assistance within Venezuela were provided by the University of Zulia. Mr. Guillermo Alvarado Duran and many of the University staff were of great help during the collecting trips. Facilities were also provided by the University of Los Andes and the University of Central Venezuela at Maracay. Mr. Robert Brooks and Mr. John McLaughlin (UCD) assisted with the tardigrade collections and Mr. Chris Williams (ETSU) helped with the sorting.

LITERATURE CITED

- Barros, R. de. 1939. *Pseudechiniscus juanitae*, nova espécie de Tardigrado. Bol. Biol. S. Paulo (N.S.) 3:52–54.
Horning, D. S. Jr., R. O. Schuster, and A. A. Grigarick. 1978. Tardigrada of New Zealand. New Zealand J. Zool. 5:185–280.

- Mihelčič, F. 1967. Ein Beitrag zur Kenntnis der Tardigrada Argentiniens. Veröff. Zool. Bot. Ges., Wien 107:43-56.
- Ramazzotti, G. 1964. Tardigradi del Cile, III con descrizione delle nuove specie *Oreella minor* e *Pseudechiniscus lateromamillatus*. Atti Soc. Ital. Sci. Nat. 103:347-355.
- . 1972. Il Phylum Tardigrada. Mem. Ist. Ital. Idrobiol. 28:1-732.
- Richters, F. 1909. Tardigraden-studien. Ber. Senekend. Naturf. Ges. 40:28-49.
- Schulz, E. 1955. Studien an marinen Tardigraden. Kieler Meeresf. 11:74-79.

***Boharticus*, N. Gen., with a Review of *Rhopalicus* Foerster and
Dinotiscus Ghesquiere (Hymenoptera: Pteromalidae)**

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This paper represents a preliminary step toward integrating knowledge of the Nearctic and Palearctic faunas of Pteromalidae. It presents a review of the known species of *Rhopalicus* Foerster and *Dinotiscus* Ghesquiere, in which a new Nearctic species of *Rhopalicus* is described (*zola*), the Palearctic species *Dinotiscus aponius* is reported for the first time from the Nearctic, two Nearctic species of *Dinotiscus* (*acutus*, *polygraphi*) are synonymized under a Palearctic name (*D. eupterus*), the Nearctic species *D. burkei* is synonymized with *D. dendroctoni*, and keys to the 11 known species of both genera are given. All species are associated with wood-infesting beetles. Additionally, the new genus *Boharticus* is described for 4 new species associated with Cecidomyiidae on *Juniperus*.

The findings of this paper are based upon a comparison of type-specimens and identified material from both the British Museum (Natural History) (hereafter BMNH) and the United States National Museum (USNM). Additional material was borrowed from the Florida State Collection of Arthropods (FSCA), Gainesville, Florida. Host records are mainly from Burks (1979) and Graham (1969), but nomenclatural changes for these records have been made based upon newly published references (Wood, 1982; O'Brien and Wibmer, 1982). In the case of generic synonymy, I have relied upon the taxonomic conclusions reached by Graham (1969) who, for many years, has studied the types of European Pteromalidae. His research furnishes a base for much future pteromalid work.

Many years ago, when I began my chalcidoid studies, I desperately needed a starting point such as that provided by Graham (1969). By taking up a group wherein scarcely anyone was working, I assured myself of one thing . . . no help whatsoever! At least it seemed that way at the time. But upon the deliberations of numerous passing years, I now realize that I really did have one resource of help and a steady one at that. It was the source of direction, of purpose, and of inspiration that came from Dick Bohart, an entomologist's entomologist. Without "Doc" there somewhere, always willing to help, I should surely have stumbled once too often. Dick and his wife, Margaret, were generous to me in particular, and to their students in general. I take great satisfaction in dedicating this work to both of them.

PTEROMALID CLASSIFICATION

Before presenting the descriptive aspects of this paper, a few general comments should be made about the state of our knowledge of pteromalid taxonomy. Current world figures place the number of valid pteromalid species at 3111 and the number of genera at 611 (J. S. Noyes, pers. comm.). In the Nearctic there are nearly 400

species in 129 genera (Burks, 1979). These figures are misleadingly low if we consider the potential number of undescribed taxa and the fact that the group has been poorly collected and studied.

In the Nearctic there has been little revisionary work which would serve as a basis for the study of pteromalid taxonomy. In the Palearctic, however, Graham (1969) published a monograph of the Pteromalidae of northwestern Europe in which he provided keys to all European genera. Comparison of Graham's work with the most recent Nearctic catalog (Burks, 1979) shows that over two-thirds (ca. 80 of 110) of the genera treated by Graham are Holarctic. Therefore Graham's work could serve an important function in first helping us to understand the Nearctic fauna, and more importantly, in providing a starting point for the integration of the Nearctic and Palearctic faunas.

As important as Graham's work is, however, its indiscriminate use may cause problems. The description of the new genus *Boharticus* has highlighted some of these problems and I point them out here for precautionary reasons. To begin with, relationships of genera and diagnostic characters for them are not discussed in Graham's text. Although genera are apparently arranged in a phylogenetic system within the text, there is little or no discussion of relationships between them. To *define* genera it is therefore necessary to search through the keys for useful characters. However, when one does this for well-known genera with large numbers of species, such as *Chlorocytus* Graham, *Pteromalus* Swederus, and *Mesopolobus* Westwood (ca. 120 species total), it is apparent that they are not clearly defined. For example, these 3 genera run to 24 different couplets in the key. The conclusion one draws from this is that species grouped in each of these genera cannot be defined by shared, unique characters (i.e., synapomorphies). A more serious problem is that a large proportion of genera (54 of 128 Palearctic genera) are represented by only 1-species each and that these genera are often distinguished by a character (or combination of characters) which would be only of specific value in one of the larger three genera listed above. For example, characters associated with pronotal collar, clypeus, flagellomere ratios, color, and abdominal shape may be used to distinguish groups of species within genera (via numerous couplets in the key) as well as to define genera with single species.

The 4 species which I place in *Boharticus*, new genus, serve to illustrate the rather poor definitions and lack of understanding we have within the Pteromalidae. Running these species individually through Graham's key results in one being placed in *Dinotiscus* Ghesquiere, two being placed in *Rhopalicus* Foerster, and one being placed in *Trychnosoma* Graham. For reasons I will discuss under the description of *Boharticus*, I believe the species of this genus represent a natural grouping based upon thoracic and host-related characters. However, the act of defining *Boharticus* causes the distinctions between *Dinotiscus* and *Rhopalicus* to become unclear. That is, the latter two genera now are defined by characters which appear to be more appropriate for separating species. At present, I can do little to resolve the generic problems between *Rhopalicus* and *Dinotiscus*. Although I have seen all the species of these genera and I have provided a modification of Graham's key which will separate them, their true status will require a major taxonomic revision of the entire family. Such a revision will require analysis of new sets of characters (such as the thoracic characters used to define *Boharticus*) as well as reexamination of previously used ones.

***Boharticus* Grissell, NEW GENUS**

Type-species.—*Boharticus richardi* Grissell, new species.

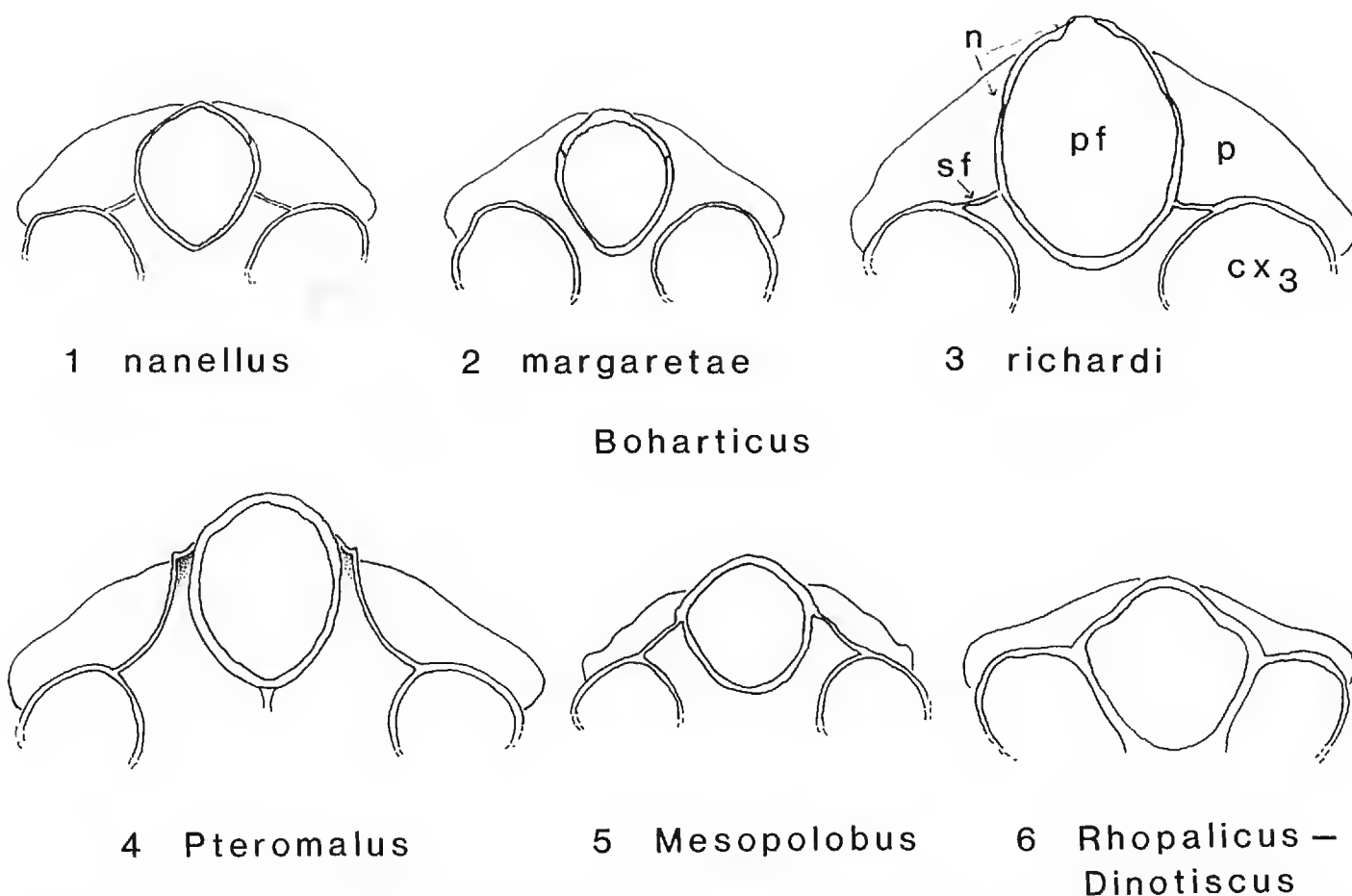
Occiput without carina; clypeus entire; lower face not protuberant at level of toruli; antenna with 2 anelli, 6 flagellomeres, and 3 segmented club; torulus 2 to 3 diameters above level of ventral margins of eyes; both mandibles with 3 denticles, uppermost denticle truncate. Almost entire thorax similarly and heavily reticulate including postalar plate (Fig. 12), upper epimeron, dorsellum, and propodeum; scutum with notauli on anterior half; frenum weakly indicated by finer sculpture on area anterior to it; dorsellum well developed (i.e., not narrowed or reduced) and protruding at least as far as apex of scutellum, not separated from scutellum by costate groove; propodeum with or without complete median carina, without plicae or costula; nucha represented by narrow, lunate strip which may be triangularly enlarged medially in some species (e.g., Fig. 11); supracoxal flange not joined to nucha (but may be joined to inner one-third of petiolar foramen, Figs. 1, 3); hindcoxa with or without setae dorsally; forefemur not enlarged or emarginate ventrally; hind tibia with one apical spur; forewing with maculae, postmarginal and marginal veins longer than stigmal, postmarginal equal to or shorter than marginal, stigma not enlarged. Gaster lanceolate, petiole transverse and scarcely visible, terga entire on posterior margins, bristles of cerci equal in length, ovipositor not exerted, tip of hypopygium not (or barely) reaching middle of gaster.

Etymology.—Named in honor of Richard M. Bohart on the occasion of his 70th birthday. The gender is masculine.

Discussion.—The genus *Boharticus* is recognized as monophyletic based upon the following synapomorphies:

- 1) All species share a structurally unique thorax as follows:
 - a) On the propodeum in dorsal view, the area between the nucha and the supracoxal flange is not connected by a carina (thus the propodeum appears to turn under at this point). In *B. margaretae* this connecting carina is absent (Fig. 2). In *B. richardi*, *nanellus*, and *apilosus*, however, the carina curves around the inner margin of the coxal cavity and joins the propodeal foramen in the inner one-third (Figs. 1, 3; compare this with Fig. 6 for *Rhopalicus* and *Dinotiscus*);
 - b) The thorax is heavily and similarly reticulate on nearly every surface, but especially on the upper epimeron, the dorsellum, the postalar plate (Fig. 12), and the propodeum.
- 2) All species are associated biologically with gall-formers on the plant genus *Juniperus*. The gall-formers are known to be Cecidomyiidae for 3 species of *Boharticus*. The fourth species is known only from juniper "berries," but this is probably an error in identification because the galls of several cecidomyiids (e.g., *Walshomyia*) resemble fruiting structures.

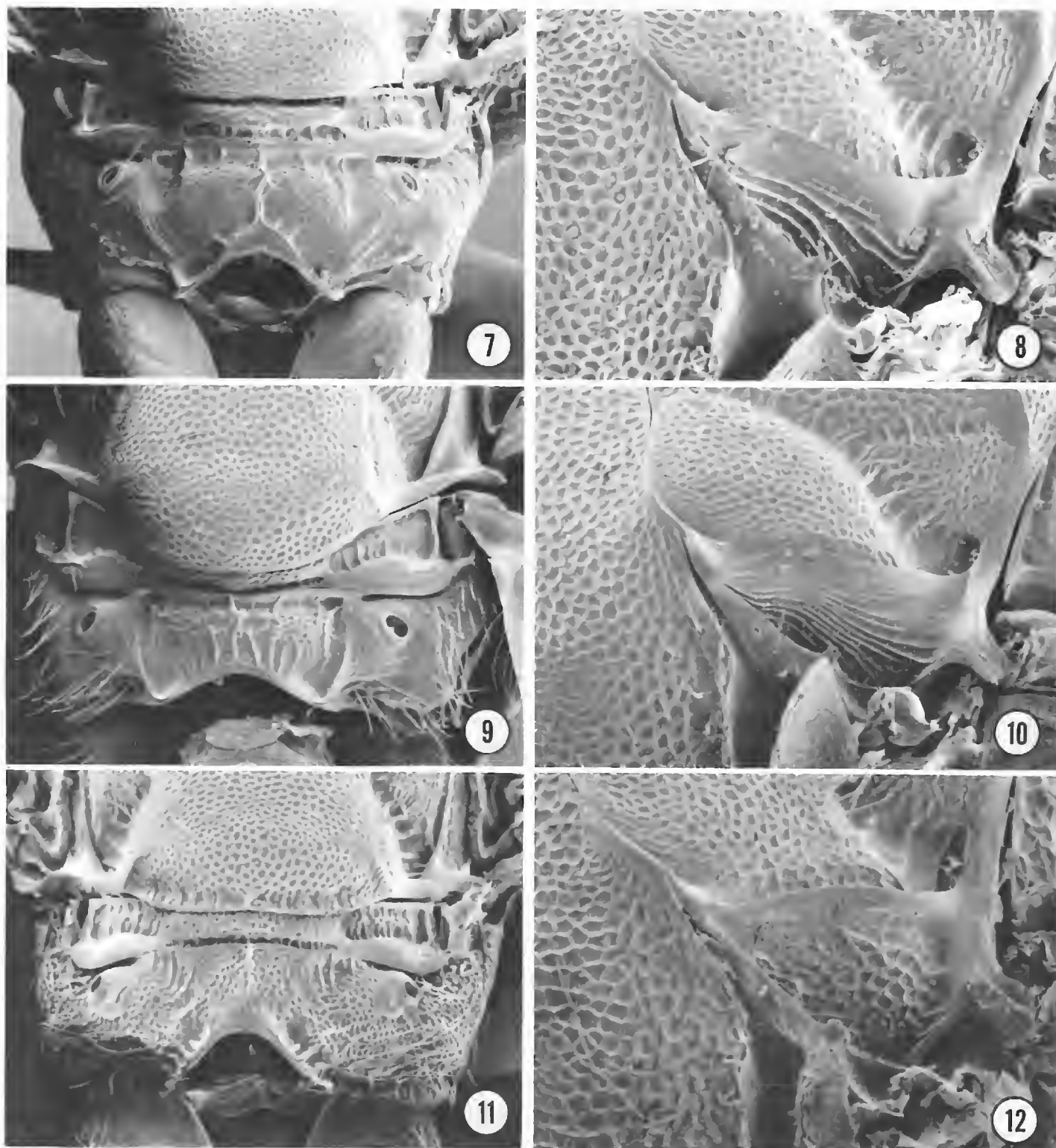
If the members of *Boharticus* are placed within the context of Graham (1969), 3 of the 4 species would key to couplet 205 which includes *Dinotiscus* and *Rhopalicus*, and the fourth would key to *Trychnosoma* Graham (couplet 110; for discussion see *B. apilosus* below). *Boharticus* differs from both *Rhopalicus* and *Dinotiscus* as follows:



Figs. 1-6. Ventral view of propodeum and posterior apex of thorax (cx3 = hindcoxal foramen; n = nucha; p = propodeum; pf = propodeal foramen; sf = supracoxal flange).

- 1) All species of these latter 2 genera (as well as other related Pteromalinae genera) share the following thoracic characters:
 - a) In dorsal view, the supracoxal flange is connected to the nucha by a carina (ventrally the carina may be seen to join the nucha in the outer one-third, Fig. 6);
 - b) The thorax is not everywhere heavily or evenly reticulate; at least the postalar plate (Figs. 8, 10) is vertically carinate (may be smooth on outer margin or with vertically elongate reticulations on inner margin), the upper epimeron and/or dorsellum may be smooth, and the propodeum is less heavily sculptured than the apex of the scutellum.
- 2) All species of these genera are parasitic upon wood-infesting beetles of the families Scolytidae and Curculionidae.

The propodeal character involving the supracoxal flange is not the easiest of characters to interpret, and I offer these additional notes as a guideline. Initially, in trying to assess the structure of the flange, it was necessary to remove the abdomen of each specimen for a better view. However, the flange may be seen in dorsal view, without removing the abdomen, by tilting the specimen forward. In genera such as *Dinotiscus* and *Rhopalicus* the flange is easily seen from this position (Figs. 7, 9) partially because it is well developed and partially because it is relatively near to the posterior margin of the propodeum (Fig. 6). In *Boharticus*, the flange is either absent (Fig. 2) or weakly developed and positioned toward the anterior of the propodeal foramen (Figs. 1, 3). In ventral view, and with the



Figs. 7–12. Scanning electron micrographs. 7, 8, *Rhopalicus pulchripennis*. 9, 10, *Dinotiscus thomsoni*. 11, 12, *Boharticus richardi*. (Left, propodeum; right, postalar plate.)

abdomen removed, the supracoxal flange of *Rhopalicus* and *Dinotiscus* is continuous with the nucha and there is virtually no sclerite between the propodeal foramen and the hindcoxal foramen (Fig. 6). In *Boharticus*, however, the supracoxal flange (if present) does not join the nucha, but instead joins the propodeal foramen and there is a sclerotized area between the propodeal and hindcoxal foramina (Figs. 1–3).

It is not known how useful this character will be throughout the Pteromalinae. However, in examining many species of *Mesopolobus* Westwood, which share the narrowed nucha of *Boharticus*, *Dinotiscus*, and *Rhopalicus*, it was found that the character was stable for the genus, although it was expressed in a manner intermediate (Fig. 5) to *Boharticus* (Fig. 1–3) and *Rhopalicus*-*Dinotiscus* (Fig. 6). In

Mesopolobus there is a sclerotized area between the foramina (as in *Boharticus*) but the supracoxal flange joins the nucha (as in *Rhopalicus-Dinotiscus*). In *Pteromalus*, a genus separated from the above mentioned genera by virtue of an elongate, sculptured nucha, the supracoxal flange is also consistently well developed, elongate, and joins the nucha as in *Mesopolobus* (cf. Figs. 4 and 5). This character is constant for the species of *Pteromalus* I have examined.

For practical purposes the following couplets are proposed to replace those numbered 205 to 206 in Graham (1969:387). This replacement is based upon all known species of *Boharticus*, *Dinotiscus*, and *Rhopalicus*.

- 205 (53, 124) Hindtibia with 2 apical spurs (Palearctic) . . . *Acrocormus* Foerster
 - Hindtibia with 1 apical spur 206
- 206 (205) Nearly entire thorax similarly and heavily reticulate (note especially postalar plate (Fig. 12), upper epimeron, dorsellum, and propodeum); supracoxal flange not joined directly to nucha (Figs. 1-3; may be joined to lower third of propodeal foramen), in dorsal view flange not easily seen
 *Boharticus* Grissell
 - Thorax not similarly reticulate throughout, postalar plate vertically carinate (Figs. 8, 10; may appear elongately reticulate towards inner margin and smooth along outer), epimeron may be smooth above, propodeum alutaceous medially or at least less heavily sculptured than apex of scutellum; supracoxal flange joined to nucha and visible in dorsal view (Figs. 7, 9) 207
- 207 (206) Pronotum carinate; propodeal nucha medially a semicircular, narrowed carina (Fig. 9) *Dinotiscus* Ghesquiere
 - Pronotum without carina; propodeal nucha medially expanded as triangular area (Fig. 7) *Rhopalicus* Foerster

KEY TO FEMALE *BOHARTICUS*

1. Basal cell of forewing essentially bare (with 0 to 10 setae, but if questionable then wing spot parallels marginal vein and parastigma (Fig. 16)); pronotal collar carinate 2
 - Basal cell of forewing fairly evenly setose (usually over 10 setae, but if questionable, as in some specimens less than 1 mm, then wing spot confined to stigmal area, Fig. 14); pronotum without carina 3
2. Hindcoxa with basal setae; forewing with maculae expanded at both stigmal and parastigmal areas (Fig. 13) *margaretae* Grissell, n. sp.
 - Hindcoxa without basal setae; forewing with macula expanded only at stigmal area (Fig. 16) *apilosus* Grissell, n. sp.
3. Forewing macula surrounding stigmal vein and paralleling marginal vein (Fig. 15); abdomen about 3× as long as wide; nucha expanded medially as carina which reaches (or nearly) dorsum of propodeum (Fig. 11)
 *richardi* Grissell, n. sp.
 - Forewing macula restricted to stigmal area (Fig. 14); abdomen less than 1.5× as long as wide; nucha parallel-sided medially, not extending dorsally as carina *nanellus* Grissell, n. sp.

***Boharticus richardi* Grissell, NEW SPECIES**

(Figs. 3, 11, 12, 15, 19)

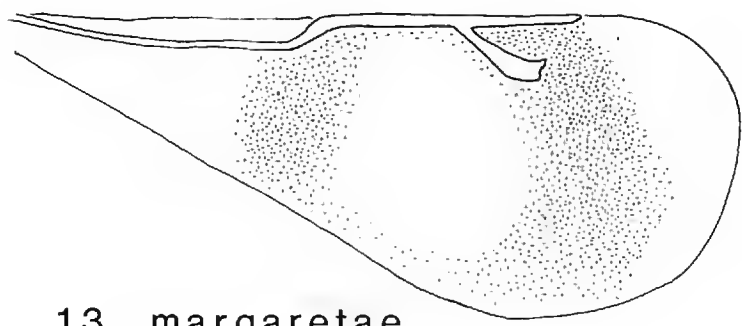
Holotype female.—Body length 5.8 mm. Head and thorax (excluding legs beyond coxae) metallic green; abdomen metallic red with green reflections; femora and tibiae smoky orange; scape, tegula, and tarsomeres 1–4 straw-yellow; antenna and tarsomere 5 brown, wing veins brown becoming slightly lighter towards postmarginal. Head, thorax, and abdomen (except posterior margin of terga nearly smooth) with reticulate sculpture. Face as shown in Fig. 19; toruli $2\times$ own diameter above ventral margin of eyes (5:10); intermalar distance $2.1\times$ malar distance (32:15); eye $2.3\times$ length of malar distance (34:15); ratio of lateral ocellus diameter: ocellocular distance: postocellar distance as 5:10:14; ratio scape: pedicel: anelli: flagellomeres 1–6: club as 50:14:3:3:17:16:16:14:13:13:27, flagellomeres starting $1.6\times$ as long as wide ($F1 = 16:10$) and becoming as long as wide ($F6 = 13:13$). Pronotal collar not margined anteriorly, dropping almost perpendicularly to neck; nucha angled medially forming an acute triangle which narrows and continues to dorsal margin of propodeum (Fig. 11); basal fovea about size of spiracle and midway between spiracle and median carina, apical fovea about as large as basal one, 10–15 setae present posterior to spiracle, callus evenly setose; epimeral scrobe nearly straight, situated at midpoint of epimeron and occupying about $\frac{1}{7}$ of length; wing veins with ratio of submarginal: marginal: postmarginal: stigmal as 48:16:16:10; basal cell with at least 25 setae, setae present on cubital and basal veins, costal cell with complete anterior setal row beneath and several rows beneath on distal $\frac{1}{3}$; maculations as shown in Fig. 15; hindcoxa with setae basally. Abdomen keel-shaped (i.e., somewhat laterally compressed but dorsally flat), with heavy, reticulate sculpture, with ratio of T1–7: ovipositor sheaths as 15:10:8:8:12:17:15:3; ratio length: width as 43:14; ratio abdomen: thorax as 43:23.

Male.—Unknown.

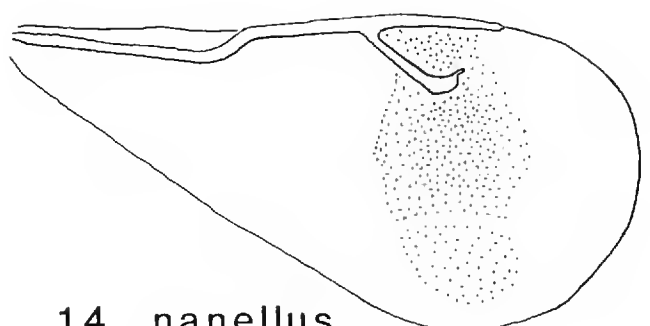
Type material.—Holotype ♀, USNM #100592; CALIFORNIA, Fresno Co., Coalinga, 21 March 1960, H. L. Wilson, ex Juniper galls. Paratypes: 7 ♀, same data as holotype; 1 ♀, same data except 20 March 1959, ex “Juniper berries;” 3 ♀, CALIFORNIA, Los Angeles Co., Vasquez Rocks, 25 January 1963, ex pinecone gall on *Juniperus californica*; 2 ♀, CALIFORNIA, Stanislaus Co., Del Puerto Canyon, E. E. Grissell, R. F. Denno, em. 15 March 1971 ex cecidomyiid cone gall on *Juniperus californica* collected 6 March 1971. All specimens in USNM except 2 ♀ in British Museum (Natural History). (The “pine-cone” gall is made by a species of Cecidomyiidae in the genus *Walshomyia* according to R. J. Gagne, personal communication. The juniper “berry” record is probably a mistake, as some *Walshomyia* galls have the appearance of a fruiting structure.)

Etymology.—Named for Richard M. Bohart, mentor, colleague, and friend.

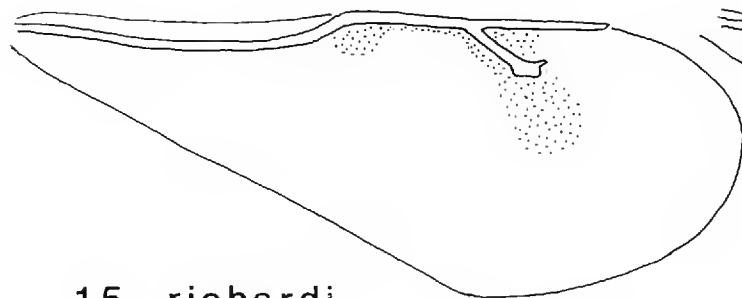
Variation.—Females of *B. richardi* range in length from 4.9 to 6.2 mm. Color of the head and thorax is metallic green in most specimens (15) but 1 specimen is metallic blue. The abdomen is metallic red in 13 specimens and metallic green tinged red in 2. The maculation pattern of the forewing is consistent, but the intensity varies from very dark brown (with distinct edges) to a washed out brown (with indistinct edges, i.e., the pattern fades into the surrounding clear areas). The number of setae of the basal cell is variable, but the cell is fairly evenly covered with 20 or more setae. All the specimens have the nucha extended dorsally as a keel or carina, but in 2 specimens this carina fades toward the dorsal propodeal



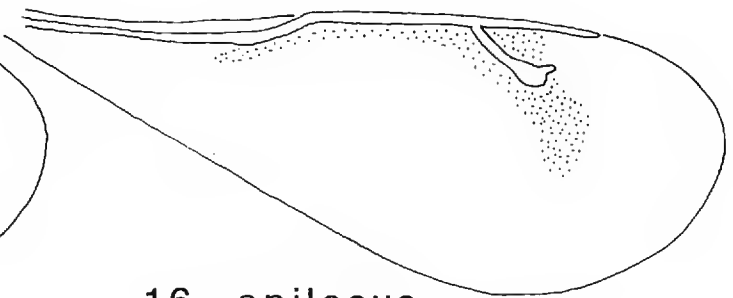
13 margaretae



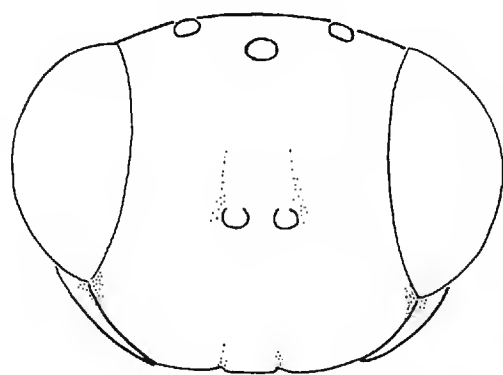
14 nanellus



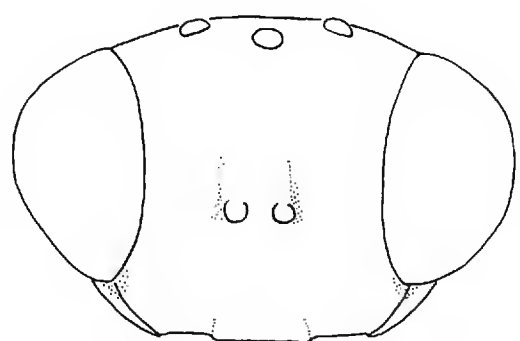
15 richardi



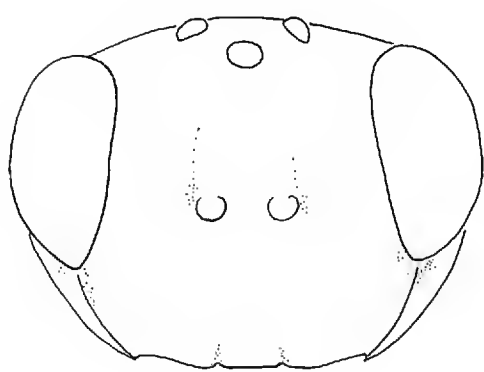
16 apilosus



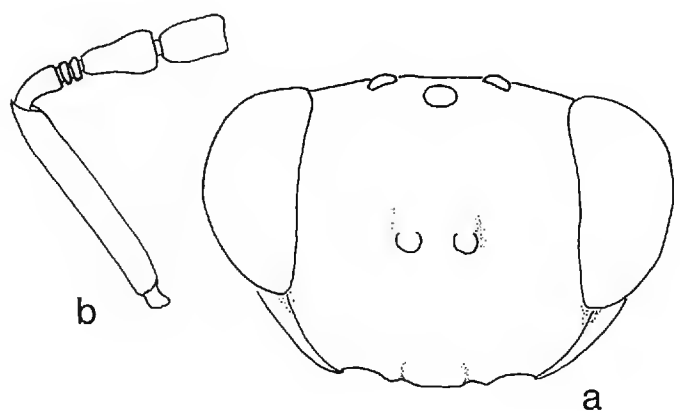
17 margaretae



18 nanellus



19 richardi



20 apilosus

Figs. 13-20. *Boharticus* n. spp. 13-16, forewing (setae not shown). 17-20, face, frontal view; 20b, scape, pedicel, anelli, flagellomeres 1 and 2.

margin and does not reach it. The specimens from Del Puerto Canyon have the nucha less pronounced than other specimens, but the carina continues to the propodeal margin. The basal fovae vary from a simple depression about the size of the spiracle to a depression several times as large with 2 or 3 carinae present. The epimeral scrobe may be short as in the holotype or it may occupy half of the epimeral length.

Discussion.—This is the most striking member of the genus. It is the largest species (to over 6 mm), and the abdomen is generally metallic red which contrasts distinctly with the green thorax. The abdomen is considerably elongate ($3\times$ longer than wide, $2\times$ longer than the thorax), keel-shaped, and as heavily sculptured as the thorax. Although *richardi* shares the setose basal cell with *nanellus*, the two do not appear particularly related. They differ in a number of characters as follows: in *richardi* the eye height is less than $2.5\times$ the malar distance (nearly $3.5\times$ in *nanellus*), F1 is over $1.5\times$ longer than wide and the flagellomeres become quadrate at F6 (F1 is quadrate in *nanellus*, and flagellomeres become wider than long by F6), the fore and midcoxae are green (yellow in *nanellus*), the abdomen is keel-shaped and flat dorsally with heavy, reticulate sculpture (dorso-ventrally sunken in *nanellus*), and T1 and 7 are subequal (T1 is $2.5\times$ as long as T7 in *nanellus*). Additional characters may be found in the key.

***Boharticus margaretae* Grissell, NEW SPECIES**

(Figs. 2, 13, 17)

Holotype female.—Body length 3.0 mm. Head and thorax (excluding legs beyond coxae) metallic green; abdomen blackish purple; femora, tibiae, and tegula, smoky orange; scape and tarsi straw-yellow; antenna and wing veins brown, forewing with 2 brown spots. Head, thorax, and abdomen (except posterior margins of terga smooth) covered with reticulate sculpture. Face as shown in Fig. 17; toruli $2.7\times$ own diameter above ventral margin of eyes (6:16); intermalar distance $2.3\times$ malar distance (21:9); eye $2.9\times$ length of malar distance (26:9); ratio of lateral ocellus diameter : ocellocular distance : postocellar distance as 6:12:21; ratio scape: pedicel : anelli : flagellomeres 1–6 : club as 40:14:2:2:10:9:9:9:9:8:17, flagellomeres starting slightly longer than wide (F1 = 9:7) and becoming slightly wider than long (F6 = 9:8). Pronotal collar margined anteriorly, dropping almost perpendicularly to the neck, collar laterally rounded off; nucha evenly curved and parallel-sided medially, disappearing at lateral edges, basal foveae essentially absent, apical fovea well developed, 3 or 4 long setae present posterior to inner margin of spiracular sulcus, callus with about 5 setae; epimeral scrobe a long, crescentric groove reaching from near posterior margin to anterior margin; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as 45:21:19:14; basally, cubital and basal veins without setae, wing essentially bare from speculum to base (only a few setae present near intersection of cubital and basal veins, and costal cell with anterior row beneath); maculations as shown in Fig. 13; hindcoxa with setae basally. Abdomen keel-shaped, dorsally flattened, with reticulate sculpture, with ratio T1–7 : ovipositor sheaths as 12:12:14:13:10:8:7:6; ratio length : width as 40:18; ratio abdomen : thorax as 40:26.

Male—Unknown.

Type material.—Holotype female, USNM #100593; COLORADO, *El Paso Co.*, Garden of the Gods, 20 July 1915, J. H. Pollock, [ex “cecidomyiid larvae

in old buds"], *Juniperus monosperma*, "Hopkins U. S. 12946a." Paratypes: 8 ♀, same data as holotype; 1 ♀, ARIZONA, *Mohave Co.*; 8 miles SW Peach Springs, 4500', 7 September 1964, C. W. O'Brien, ex *Juniperus*. All specimens in USNM, except 1 ♀ in British Museum (Natural History). (Note: The bracketed material above was taken from Hopkins cards on file at the USNM; according to these cards, the gall material was collected on 1 July 1915 and parasites emerged on 20 July.)

Etymology.—This attractive little species is named for Margaret Bohart who, for many years, has shown much generosity and hospitality to Dick's students.

Variation.—Females vary from 2.3 to 2.7 mm. The thorax varies from metallic green to metallic blue. The wing maculations are equally intense on all of the specimens. On several specimens the basal foveae are indicated by a slight depression bordered on the inner side by a short carina; the pit is equal in size or smaller than the spiracle.

Discussion.—This species is similar to *apilosus* in having the basal cell of the forewing nearly asetose and in the carinate pronotum. There are rather striking differences between the species especially in forewing maculations and hindcoxal setae (as stated in the key). The flagellomeres of *margaretae* range from barely longer than wide (F1) to wider than long (F6), whereas in *apilosus*, F1 is nearly 2× as long as wide and F6 is longer than wide. Also in *margaretae* F1 is cylindrical but in *apilosus* it is constricted basally (Fig. 20b). Additionally, the abdomen of *margaretae* is rigid with dull reticulate sculpture somewhat as on the thorax, but in *apilosus* the abdomen is distorted and sunken with shiny, alutaceous sculpture.

***Boharticus nanellus* Grissell, NEW SPECIES**

(Figs. 1, 14, 18)

Holotype female.—Body length 1.7 mm. Head, thorax, and upper $\frac{3}{4}$ of hindcoxa metallic green; yellow are: scape, fore and midcoxae (and apex of hindcoxa), legs (except tarsomere 5 dark brown), and abdomen (which is smoky dorsally); wing veins and tegula straw colored; flagellum brown. Head and thorax evenly covered with reticulate sculpture; abdomen evenly covered with reticulations but not as raised as on thorax (also difficult to see with reflected light because of yellow background). Face as shown in Fig. 18; toruli nearly 3× own diameter above ventral margin of eyes (4:11); intermalar distance 2.4× malar distance (22:9); eye 2.4× length of malar distance (22:9); ratio lateral ocellus diameter: ocellocular distance: postocellar distance as 5:10:15; ratio scape: pedicel: anelli: flagellomeres 1-6: club as 23:8:1:1:5:5:4:4:5:5:12, flagellomeres starting 1× as long as wide (F1 = 5:5) and becoming wider than long (F6 = 6:5). Pronotal collar in dorsal view dropping perpendicularly to the neck but without carina; nucha a narrow carina which is scarcely widened medially, basal and apical foveae about the size of spiracle (not very well developed); 2 or 3 long setae present posterior to spiracle, callus with about 5 or 6 setae; epimeral scrobe poorly defined, situated at midpoint of epimeron and occupying about $\frac{1}{7}$ the length; wing veins with ratio of submarginal: marginal: postmarginal: stigmal as 55:30:28:20; wing heavily setose with areas bare as follows: speculum, area beneath cubital vein, basal half of costal cell (except row of setae along lower foremargin); maculations as shown in Fig. 14, weakly expressed and diffuse; hindcoxa with several setae basally. Abdomen

dorsoventrally sunken, with ratio T1-7 : ovipositor sheaths as 16:12:10:10:11:14:6:1; ratio length : width as 40:32; ratio abdomen : thorax as 40:33.

Allotype male.—Body length 1.5 mm. Color as for female except abdomen metallic reddish. Similar to female (including ratios) except as follows: flagellomeres with recurved setae which are about as long as segment; wing maculation restricted to weak stain posterior to stigma; ratio T1-6 as 14:5:4:4:3:2.

Type material.—Holotype female, USNM #100594; OHIO, *Wayne Co.*, Wooster, 25 June 1961, J. E. Appleby, ex tip midge on *Juniperus horizontalis*. Allotype ♂, 1 ♀, 2 ♂ paratypes same data as holotype; 1 ♀, 1 ♂ paratype same data as holotype except ex *Juniperus virginiana*; 63 ♀, 66 ♂ paratypes, FLORIDA, *Alachua Co.*, Gainesville (Doyle Conner Building), 15-26-XI-1973, E. E. Grissell, sweeping *Juniperus salicicola* (Small) Bailey. Holotype ♀ and paratypes from Ohio in USNM; paratypes from Florida in FSCA, USNM, BMNH, and the Canadian National Collection, Ottawa.

Etymology.—From the diminutive (-ellus) of *nanus*—a dwarf, in reference to the small size of this species.

Variation.—Males and females from the Ohio population are generally larger in size than the Florida population. Males from Ohio range in length from 1.3 to 1.5 mm and females are about 1.6 mm long. Females from Florida, however, range in size from 0.8 to 1.5 mm and males from 0.7 to 1.0 mm. The wing maculation varies considerably even within the 3 females from Ohio. In the holotype and 1 female from *J. virginiana* the forewing spot is weak and occupies the anterior half to third of the wing; in 1 female from *J. horizontalis* the spot nearly reaches the hindmargin of the wing (but with a hyaline break at one-third the distance from the posterior margin). Larger females from Florida (ca. 1.5 mm) have the wing spot as for the holotype, but small females (ca. 0.8 mm) have the spot restricted to a weak stain posterior to the stigma. In males the spot resembles that of small females or is absent. In general, as the specimens become smaller (either sex), the yellowish coloring of the abdomen and hindcoxae becomes darker. The mid and forecoxa, legs, and scape remain yellow even in the smallest male. In small specimens, the number of setae in the basal cell is reduced to about 10, but the setae are fairly evenly spaced. In both males and females, the epimeral scrobe may be absent regardless of the size.

Discussion.—This is the smallest species of the genus, being less than 2 mm, and the only species for which the male is known. For a discussion see *B. richardi*.

***Boharticus apilosus* Grissell, NEW SPECIES**

(Figs. 16, 20)

Holotype female.—Body length 3.2 mm. Head and thorax metallic green; scape and abdomen blackish green; legs yellowish orange except femora with greenish reflections, tibiae smoky, foretarsi and mid and hind tarsomeres all darkish brown; antennae, wing veins, and wing maculation brown. Head and thorax evenly covered with reticulate sculpture; abdomen alutaceous. Face as shown in Fig. 20a; toruli 2× own diameter above ventral margin of eyes (3:6); intermalar distance 2.1× malar distance (19:9); eye 2.6× length of malar distance (42:16); ratio of lateral ocellus diameter : ocellocular distance : postocellar distance as 3:6:9; ratio scape : pedicel : anelli : flagellomeres 1-6 : club as 36:10:2:2:11:13:12:12:12:10:20; flagellomeres starting ca. 2× longer than wide (F1 = 11:6) and remaining longer

than wide ($F6 = 10:8$); $F1$ constricted at base (Fig. 20b). Pronotal collar dropping perpendicularly to the neck, with carina along anterior margin; nucha a narrow carina which is slightly produced medially to form frail carina which reaches half way to anterior margin of propodeum, basal and apical foveae about size of spiracle (not well developed); ca. 6 long setae present posterior to spiracle, callus with about 10 setae; epimeral scrobe a long, crescentric line reaching from posterior margin to anterior; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as $45:30:25:18$; basal cell with 6 to 8 setae, speculum and area below cubital vein bare, costal cell with row of setae along anterior margin on underside and 2 sparse rows in distal $\frac{1}{3}$ on underside; maculations as shown in Fig. 16; hindcoxa without setae basally (2 or 3 setae distally). Abdomen keel-shaped, dorsally sunken due to lightly sclerotized terga, with ratio $T1-7$: ovipositor sheaths as $18:6:19:9:16:15:9:6$; ratio length : width as $49:15$; ratio abdomen : thorax as $49:25$.

Male.—Unknown.

Type material.—Holotype ♀, USNM #100595; ARIZONA, Santa Cruz Co., Patagonia, 3 October 1946, Nog. #65320, ex "*Juniper berries*." Paratypes: 5 ♀, same data as holotype. All specimens in USNM.

Etymology.—From *pilosus*—hairy and *a*—without, in reference to the lack of setae on the base of the hindcoxa.

Variation.—The number of setae in the basal cell ranges from 4 to 8. The abdomen of the type is distorted so that $T2$ and $T4$ appear shorter than for other specimens. From the specimens at hand, $T2-6$ may be subequal, or $T2$ and $T4$ may be equal and shorter than $T3$, $T5$, and $T6$. The abdomen of this species is weakly sclerotized and tends to shrivel.

Discussion.—*Boharticus apilosus* is the only species of the genus with the first flagellomere constricted basally (Fig. 20b), and also the only one with no setae on the base of the hindcoxa. For additional characters see *B. margaretae*.

Because of the lack of setae on the hindcoxa, this species would key to the genus *Trychnosoma* Graham in Graham's key (1969) to the European Pteromalidae. It differs from that genus, however by the following: 3 denticles in both mandibles (4 on right mandible of *Trychnosoma*), clypeus reticulate (radiating striae in *Trychnosoma*), forewing with maculations (hyaline in *Trychnosoma*), and the supracoxal flange not joining the nucha (joining in *Trychnosoma*).

Rhopalicus Foerster

Rhopalicus Foerster, 1856:66, 70.

Type-species: *Cleonymus maculifer* Foerster, 1840. Monotypic.

This genus is known from 4 species as follows: *tutela* (Walker) is Holarctic, *pulchripennis* (Crawford) is primarily confined to the northern Nearctic, and *brevicornis* Thomson and *guttatus* (Ratzeburg) are Palearctic. A fifth species is herein described as new and is found throughout the southeastern Nearctic. *Rhopalicus* may be defined as follows: clypeus emarginate, with 2 well-defined lobes (Figs. 21a, 22a); venter of torulus less than own diameter above line connecting ventral margins of eyes or slightly below; pronotum without carina; thorax not similarly reticulate throughout, at least postalar plate vertically carinate (may appear elongately reticulate towards inner margin and smooth along outer), epimeron may

be smooth above, propodeum nearly shiny or alutaceous medially (but as reticulate as scutellum in *zola*e and some *pulchripennis*); nucha medially expanded as triangular area which narrows to median carina and meets (or nearly) anterior margin of propodeum (Fig. 7); supracoxal flange joined to nucha (as in Fig. 6); forewing with or without maculations; postmarginal and marginal veins longer than stigmal, and postmarginal at least slightly longer than marginal, stigma not enlarged in female, but may be elongate as in Fig. 24c (in male slightly enlarged in *tutela*, Fig. 24a).

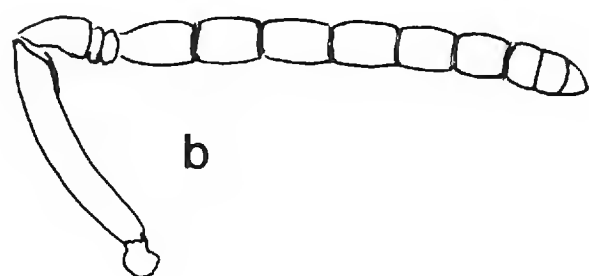
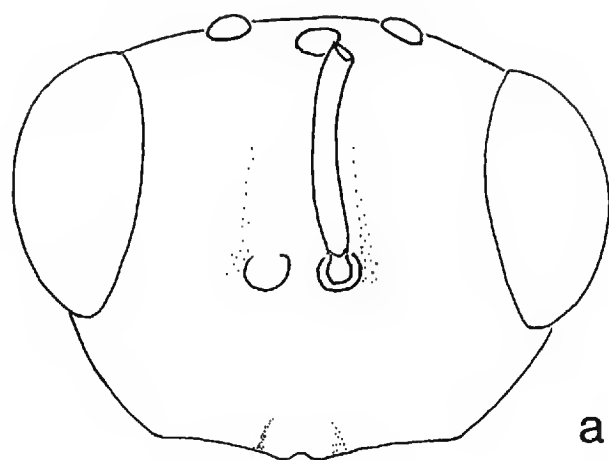
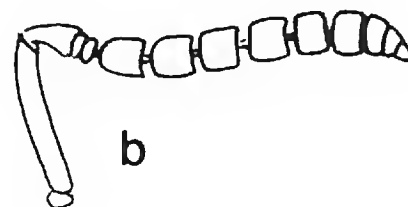
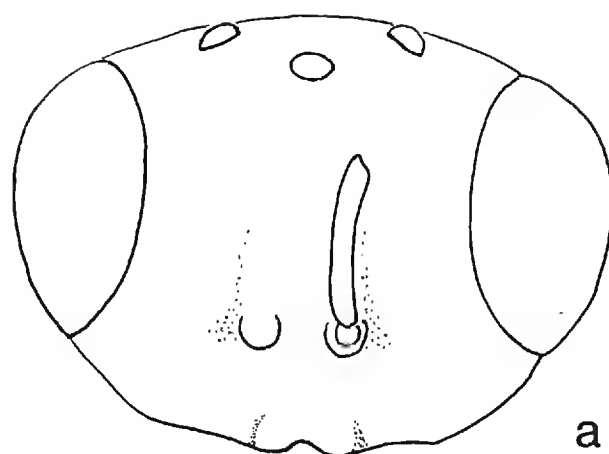
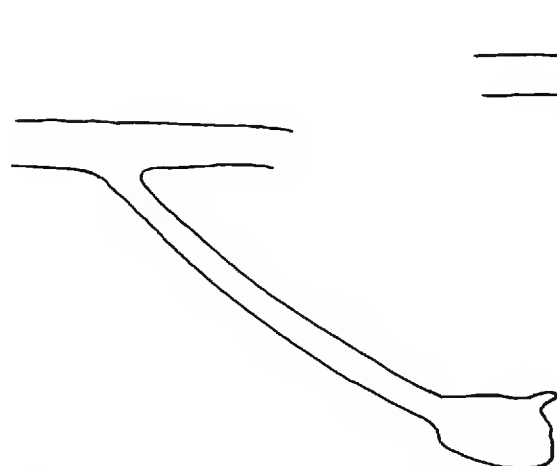
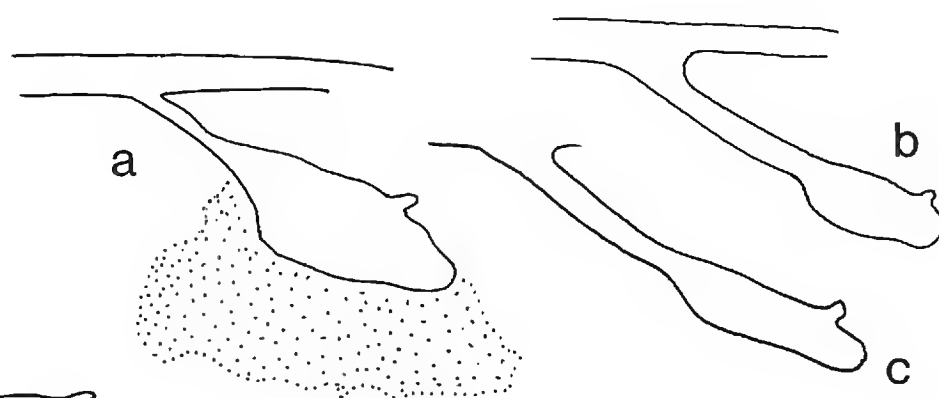
My concepts of the species discussed below are based upon Graham's work (1969: extant types examined), my identification of Palearctic specimens based upon his key, the types of the Nearctic species, and the lectotype of *tutela* (Walker) (BMNH).

KEY TO FEMALE *RHOPALICUS*

- 1. Lower surface of forewing costal cell with 2 or more rows of setae in proximal half; upper epimeron smooth; macula of wing (rarely absent) associated with stigma (Holarctic) *tutela* (Walker)
- Lower surface of forewing costal cell with 1 row of setae in proximal half; upper epimeron similarly reticulate to lower portion; macula of wing absent or associated with marginal vein 2
- 2. Scape length at most ¾ distance between top of torulus and venter of midocellus (Fig. 22a); basal vein without setae (Nearctic) *zola*e Grissell, n. sp.
- Scape length subequal to distance between top of torulus and venter of midocellus (Fig. 21a); basal vein with setae 3
- 3. Forewing hyaline; flagellomeres 1-6 together shorter than distance between eyes (dorsal view) (Palearctic) *quadratus* (Ratzeburg)
- Forewing with some form of spot; flagellomeres 1-6 together longer than distance between eyes 4
- 4. Forewing with infumate spot confined to basal half of marginal vein; dorsellum separated from scutellum by pitted groove (Palearctic) *guttatus* (Ratzeburg)
- Forewing with infumate spot beneath entire length of marginal vein; dorsellum continuous with scutellum (at most a weak line delimits the suture) (Nearctic) *pulchripennis* (Crawford)

*Rhopalicus zola*e Grissell, NEW SPECIES
(Fig. 22)

Holotype female.—Body length 2.7 mm. Head and thorax metallic blue-green; legs, apices of fore and midcoxae, and scape concolorous golden-yellow; flagellum, tegula, and abdomen dark brown; base of fore and midcoxae and entire hindcoxa metallic blue to violet; submarginal and stigmal veins brownish white, marginal, postmarginal, and stigma pale brown. Head and thorax nearly evenly covered with reticulate sculpture (except postalar plate vertically carinate); abdomen weakly sclerotized and shriveled, polished to faintly alutaceous. Face as shown in Fig. 22a; torulus slightly below line connecting ventral margin of eyes; intermalar distance nearly 2× malar distance (17:9); eye 2.3× length of malar distance (21:9); ratio of lateral ocellus diameter : ocellocular distance : postocellar distance as

21 *pulchripennis*22 *zolae*23 *quadratus*24 *tutela*

Figs. 21-24. *Rhopalicus* spp. 21, 22, a = face, frontal view; b = antennae, side view (to same scale as face). 23, 24, stigma and stigmal vein of forewing. 24, a = male; b, c = female showing variation.

6:12:22; ratio scape : pedicel : anelli : flagellomeres 1-6 : club as 26:9:1:2:9:8:7:7:6:6:10, flagellomeres starting 1× as long as wide (F1 = 9:9) and becoming 0.6× as long as wide (F6 = 6:10); F1-6 0.9× distance between eyes dorsally (44:50); scape 0.72× as long as distance between top of toruli and venter of midocellus (26:36) and 0.65× eye height (26:40). Thorax dorso-ventrally flattened, scutellum and scutum in same plane, propodeum with complete median carina; wing veins with ratio of submarginal : marginal : postmarginal : stigmal as 43:16:21:15; basal cell, basal vein, and cubital veins without setae, costal cell with complete anterior row below, and distal half with 1 additional row; weakly defined pale brown spot

present below marginal vein. Abdomen with first tergum $0.14\times$ abdomen length (7:35), abdomen $1.5\times$ longer than wide (35:23) and $1.5\times$ longer than thorax (35:23).

Allotype male.—Length 2.3 mm. Color and sculpture as for female, except pale yellow band present on distal half of tergum I and all of tergum II. Torulus slightly above a line connecting ventral margins of eyes; malar and eye ratios as for female; ratio scape:pedicel:anelli:F1–F6:club as 30:10:1:2:10:9:8:8:7:7:17; flagellomeres starting $1.4\times$ as long as wide; F1–6 $1.13\times$ least interocular distance (27:24); scape $0.84\times$ as long as distance between top of toruli and venter of midocellus (26:31) and $0.70\times$ eye height (26:37). Thorax and propodeum as for female; wing veins with same ratio as female, basal cell with several setae distally and basal vein with row of setae, costal cell as for female except distal half with 3 rows of setae instead of 2. Abdomen with first tergum $0.40\times$ abdomen length (20:50), abdomen $1.7\times$ longer than wide (50:24) and $0.96\times$ as long as thorax (50:52).

Type material.—Holotype ♀ USNM #100695; TEXAS, "Southeast Texas," Mar. 1962 to Oct. 1963, R. C. Thatcher, ex loblolly pine with *Dendroctonus frontalis* Zimmermann. Allotype ♂, 8 ♀ paratypes and 3 ♂ paratypes with same data; 6 paratypes as follows: 1 ♀, MISSISSIPPI, *Amite Co.*, 7 May 1965, N. A. Overgaard, ex pine infested with southern pine beetle; 1 ♀, TEXAS, *Hardin Co.*, June 1960, ex pine infested with *Ips*, Hopkins No. 38912; 1 ♀, GEORGIA, *Dekalb Co.*, Stone Mountain, 26 Oct. 1947, P. W. Fattig; 1 ♀, GEORGIA, *Clark Co.*, Oct. 1965, R. T. Franklin, ex *Ips* infested log of *Pinus echinata*; 2 ♀, NORTH CAROLINA, *Durham Co.*, Durham, 30 May 1942, W. Haliburton, ex *Ips avulsus* LeConte. All specimens in USNM.

Etymology.—Named for my mother who unselfishly supported a young lad's interest in bugs.

Variation.—Females of *zola*e range in length from 2.5 to 3.2 mm. The intensity and size of the forewing maculation varies from an extremely faint stain, confined to the apical fourth of the wing, to a distinct dark spot on the apical fourth which fades gradually and posteriorly to the apical third. The abdomen of all specimens is shriveled, but T1 is about one-sixth the total length and is slightly emarginate posteromedially. In females, the scape ranges from 0.68 to 0.75 times the distance from the top of the toruli to the venter of the midocellus ($n = 10$; $\bar{x} = 0.72 \pm 0.03$); in males the range is 0.84 to 0.87 times the distance ($n = 4$; $\bar{x} = 0.86 \pm 0.01$). In females the length to width ratio of F1 varies considerably and ranges from 0.93 to 1.5 times as long as wide ($n = 10$; $\bar{x} = 1.2 \pm 0.20$). F6 ranges from 0.50 to 0.67 times as long as wide ($n = 10$; $\bar{x} = 0.62 \pm 0.06$). The few males available for study have F1 and F6 relatively longer than females with F1 having a range of 1.4 to 1.7 times longer than wide ($n = 4$; $\bar{x} = 1.5 \pm 0.14$) and F6 0.75 to 0.88 times as long as wide ($n = 3$; $\bar{x} = 0.83 \pm 0.07$).

Distribution.—This species ranges throughout the southeastern United States, from North Carolina south to Georgia and east to Texas.

Hosts.—*Rhopalicus zola*e is associated with pine log rearings usually containing *Ips* and *Dendroctonus frontalis*. One pair of specimens bears the label "ex *Ips avulsus*," but I doubt that the association was actually proven.

Discussion.—Among Nearctic *Rhopalicus*, *zola*e and *pulchripennis* are superficially similar in appearance. The first species is apparently confined to the southeastern United States, whereas the latter is largely northern in range. The species

do overlap, however, and I have seen a few specimens of *pulchripennis* from Texas and Mississippi. I know of at least two instances where *zola*e has been misidentified as *pulchripennis*, and I am certain that some published records for *pulchripennis* actually refer to *zola*e. This is especially true of papers treating the southern pine beetle, *Dendroctonus frontalis* (e.g., Overgaard, 1968; Moser et al., 1971; Berisford, undated). Specimens (in USNM) reared by Overgaard in Mississippi are *zola*e, but they may have been reported as *pulchripennis* in the paper cited above.

The two species are fairly easily distinguished as follows: *zola*e has the length of the scape at most three-fourths that of the distance to the venter of the midocellus ($\bar{x} = 0.72 \pm 0.03$; range 0.68 to 0.75; $n = 10$) (Fig. 22a), whereas *pulchripennis* has the scape essentially as long as the distance to the midocellus ($\bar{x} = 1.1 \pm 0.08$; range 0.93 to 1.2; $n = 10$) (Fig. 21a). This difference is actually a result of the placement of the toruli of *zola*e at a point slightly below a line connecting the ventral margins of the eyes, whereas in *pulchripennis* the toruli are distinctly above such a line. In *zola*e the flagellomeres are generally wider than long (Fig. 22b) and in *pulchripennis* they are generally longer than wide (Fig. 21b), but measurements tend to overlap on small specimens (ca. 3.0 mm) of *pulchripennis*, thus making this character not reliable in every case. In addition, *zola*e has no setae on the basal vein of the forewing, whereas *pulchripennis* has a row of setae present.

Both *zola*e and the Palearctic species *quadratus* share the shortened scape and flagellomeres just mentioned as well as having a dorsoventrally flattened scutum and scutellum (i.e., both essentially in the same plane). In the Palearctic the degree of convexity of the scutellum can be used to separate species (as, for example, *quadratus* from *guttatus*) but in the Nearctic *pulchripennis* varies enough to make the use of this character difficult within the framework of a Holarctic key.

Rhopalicus quadratus (Ratzeburg)

(Fig. 23)

Pteromalus quadratus Ratzeburg, 1844b:203, ♀.

Pteromalus neostadiensis Ratzeburg, 1844b:204, ♀.

Rhopalicus brevicornis Thomson, 1878:43, ♀.

Discussion.—*Rhopalicus quadratus* is the only species with a hyaline forewing. The shortened flagellum (F1–6 shorter than distance between eyes) which separates *quadratus* from *guttatus* and *pulchripennis* is shared with *zola*e, but the two are readily separated by the characters given in the key.

Material examined.—I have seen 37 specimens of this species from Europe (BMNH, USNM).

Distribution.—Northwestern Europe.

Hosts.—Hedqvist (1963:80–81) gave a detailed list of the hosts for this species. All known hosts are Scolytidae of the genera *Tomicus*, *Carphoborus*, *Hylurgops*, *Ips*, *Orthotomicus*, *Phloeosinus*, and *Pityogenes*.

Rhopalicus guttatus (Ratzeburg)

Ichneumon (*Pteromalus*) *guttatus* Ratzeburg, 1844a:29 (pl. 8, fig. 5), ♀.

Discussion.—This species and *pulchripennis* share the lengthened flagellum (F1–

6 longer than distance between the eyes) and the convex scutellum. I can find no differences between them except those noted in the key.

Material examined.—Thirteen specimens from Europe determined by Boucek (BMNH) and one determined as a homotype by Ruschka (USNM).

Distribution.—Reported from Britain, Germany, Sweden, and Czechoslovakia (Graham 1969:415), and known additionally from Portugal, Yugoslavia, and Turkey (based upon specimens in BMNH).

Hosts.—Hedqvist (1963:82–83) reported that *guttatus* attacked several species of *Pissodes* (Curculionidae), but he discounted a record for *Ips* (Scolytidae).

***Rhopalicus pulchripennis* (Crawford)**

(Figs. 7, 8, 21)

Spintherus pulchripennis Crawford, 1912:168–169, ♀. Holotype ♀, USNM [examined].

Rhopalicus americanus Girault, 1916:296–297, ♀. Holotype ♀, USNM [examined].

Discussion.—Gahan (1924:16) synonymized *americanus* with *pulchripennis*. I agree with this conclusion based upon an examination of the type material. In the Nearctic, *pulchripennis* is the only species to combine both a spot beneath the marginal vein and the presence of setae on the basal vein. For additional remarks see *zola*.

Material examined.—In addition to the types of *pulchripennis* (7 ♀) and *americanus* (1 ♀), I have examined 123 specimens from North America.

Distribution.—Throughout southern Canada and the northern United States with infrequent (but confirmed) records in Texas, Mississippi, and Virginia.

Hosts.—Recorded from numerous Coleoptera as follows: Scolytidae: *Dendroctonus brevicornis* LeConte, *D. murrayanae* Hopkins, *D. ponderosae* Hopkins, *Pseudohylesinus nebulosus* (LeConte), *Scolytus unispinosus* LeConte; Curculionidae: *Cylindrocopturus eatoni* Buchanan, *C. furnissi* Buchanan, *Pissodes approximatus* Hopkins, *P. strobi* (Peck), *P. terminalis* Hopping. (Records of *pulchripennis* from *Ips* spp. (Overgaard, 1968) and from a combined rearing of *Dendroctonus frontalis* Zimmermann and *Ips* spp. (Moser et al., 1971) probably refer to *Rhopalicus zola*; see discussion under that species.)

***Rhopalicus tutela* (Walker)**

(Fig. 24)

Cheiopachus tutela Walker, 1836b:14–15, ♂, ♀. Lectotype ♀, BMNH [examined].

Cleonymus maculifer Foerster, 1840:34, ♀.

Pteromalus suspensus Ratzeburg, 1844b:189.

Pteromalus spinolae Ratzeburg, 1844b:189, ♂, ♀.

Pteromalus immaculatus Ratzeburg, 1844b:189, 205.

Pteromalus lunula Ratzeburg, 1848:193, ♀.

Pteromalus multicolor Ratzeburg, 1848:193 [n.n. for *P. spinolae* Ratzeburg 1844b:189, nec Foerster, 1840:23].

Pteromalus aemulus Ratzeburg, 1848:203.

Rhopalicus annellus Thomson, 1878:42, ♂, ♀.

Discussion.—*Rhopalicus tutela* is the largest (to 5 mm) and usually most easily distinguished member of the genus based upon the infumate spot associated with

the stigma (is is especially well developed in the males where it is associated with an enlargement of the stigma, Fig. 24a). Females rarely have the spot reduced or absent and the stigma is nearly always wider than high. In some specimens it may be nearly as long as the stigmal vein (Fig. 24c), while in others it is slightly shorter (Fig. 24b). The stigmal vein is definitely less than twice the length, however, whereas in other species the stigmal vein is 3 or more times the length of the stigma (Fig. 23). This species seems to be distantly related to others of the genus, based upon the stigmal characters and those given in the key.

In 1934 approximately 1500 specimens of this species were introduced from England into Canada for control of the Eastern spruce beetle, *Dendroctonus rufipennis* (Kirby), (reported as *piceaperda* Hopkins: Scolytidae by McGugan and Coppel, 1962); no "evidence of survival" was obtained. According to Britton (1920), however, *R. tutela* (reported as *suspensus* Ratzeburg) was reared in 1914 from *Pissodes strobi* (Curculionidae) in New Haven, Connecticut. Specimens of this rearing are now in the U.S. National Museum and confirm the fact that *Rhopalicus tutela* occurred in the Nearctic before its release from Europe in 1934. It is not known whether *R. tutela* could have been an accidental introduction of earlier times.

Material examined.—In addition to the lectotype (BMNH), I have seen 95 specimens from Europe (BMNH, USNM) and 15 from the northeastern United States (USNM).

Distribution.—*Rhopalicus tutela* is found from the northeastern United States to Quebec and Ontario in Canada (Burks, 1979), is "widely distributed in Europe" (Graham, 1969), and is reported from numerous localities in Japan (Kamijo, 1981).

Hosts.—In the Nearctic, this species has been reared from *Ips pini* (Say) (Scolytidae) and *Pissodes strobi* (Curculionidae). Hedqvist (1963) reported the biology of this species in Europe and gave a complete host list which includes numerous genera and species of Scolytidae as well as 3 species of *Pissodes*. Kamijo (1981) stated that "in Japan this species is commonly found on trunks of pine and larch infested by bark beetles, and to a lesser extent on those of spruce and fir."

UNPLACED SPECIES

Rhopalicus pallipes Provancher

Rhopalicus pallpies [sic] Provancher, 1888:407, ♀.

Burks (1964:1261) commented on the validity of this species. The type is lost, and from indications cited by Burks this species is probably an eulophid. The name was spelled *pallipes* in the index to Provancher's work, and this is considered to be the correct spelling.

Dinotiscus Ghesquiere

Dinotus Foerster, 1856:66, 70, 71. Preoccupied by *Dinotus* Guettard, 1770 (*Vermes*). Type-species: *D. bidentulus* Thomson, 1878; designated by Ashmead, 1904: 316.

Dinotiscus Ghesquiere, 1946:370. New name for *Dinotus* Foerster (1856) *nec* Guettard (1770).

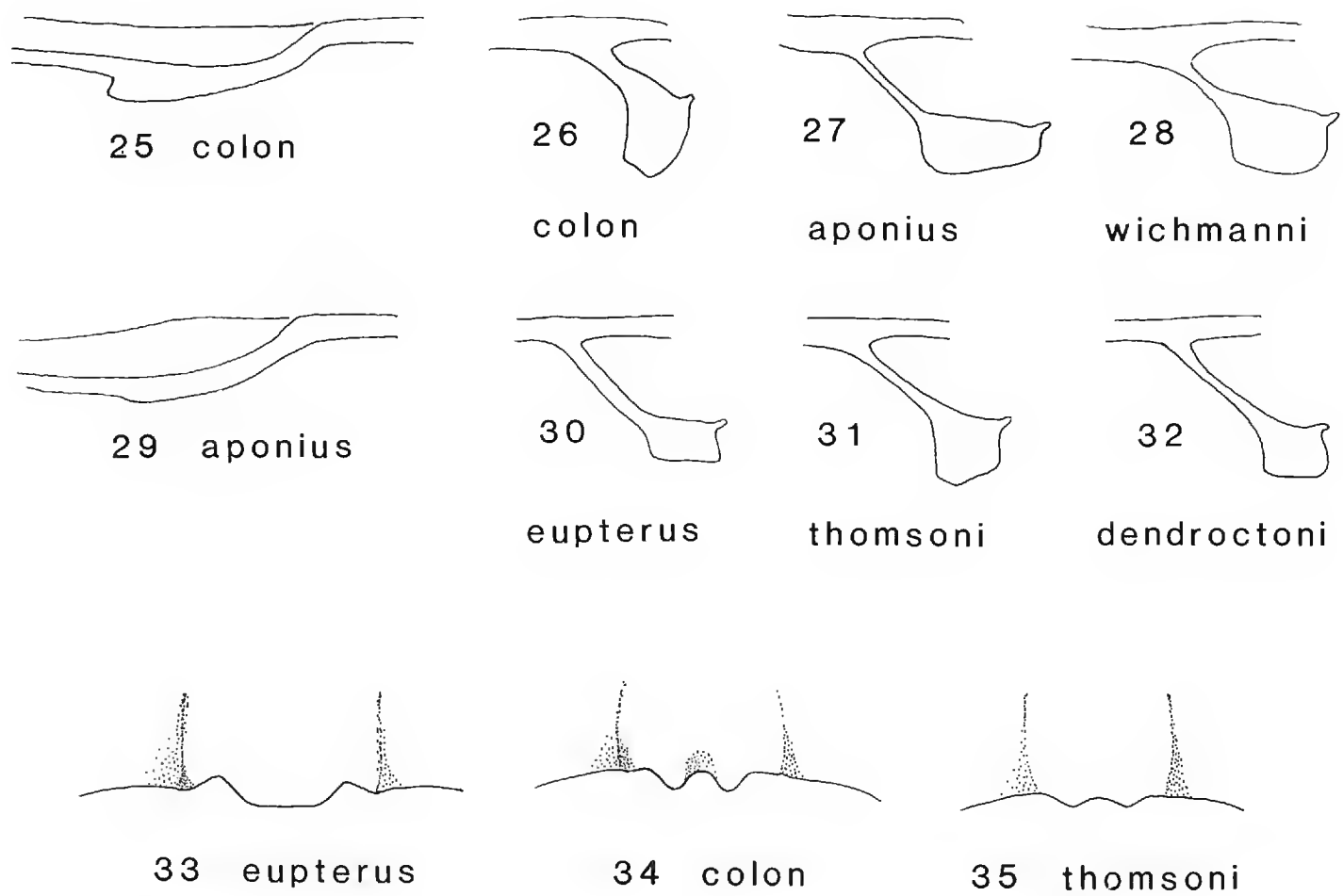
This genus is presently known from 4 Palearctic species (Graham, 1969) and 6 Nearctic ones (Burks, 1979). In this paper, however, the number of previously reported Nearctic species is reduced to 3 and a Palearctic species (*aponius* Walker) is reported as new to the Nearctic fauna. The genus now is made up of 6 species with 2 Palearctic (*colon*, *wichmanni*), 2 Nearctic (*thomsoni*, *dendroctoni*), and 2 Holarctic (*aponius*, *eupterus*).

Dinotiscus may be defined as follows: clypeus variable, either deeply emarginate (with 2 well-defined lobes), with a slight emargination, or straight; venter of torulus usually 1×, and rarely 2×, own diameter above line connecting ventral margins of eyes; thorax not similarly reticulate throughout, postalar plate vertically carinate (Fig. 10; may appear elongately reticulate), epimeron usually smooth above, propodeum nearly shiny or alutaceous medially; nucha merely a parallel sided rim (Fig. 9), rarely intersected medially by a carina; supracoxal flange joined to the nucha (as in Fig. 6); forewing with or without maculations; postmarginal and marginal veins longer than stigmal, postmarginal longer than marginal, stigma may be enlarged.

As with *Rhopalicus*, my concepts of the species are based upon Graham's work (1969), identification of Palearctic specimens based upon his key, and the types of Nearctic species. Unfortunately there do not seem to be an abundance of specific characters with which to separate species of the genus *Dinotiscus*. Although "typical" forms of the stigmal shape are useful overall, the variability of small specimens (which tend to have the stigma disproportionately reduced) detracts from the reliability of this character. I have included illustrations of typical stigmal shapes to aid in recognition of the species (Figs. 26–28, 30–32).

KEY TO FEMALE *DINOTISCUS*

1. Apical free margin of clypeus deeply emarginate, forming 2 lobes laterally (Fig. 34) 2
- Apical free margin of clypeus straight (Fig. 33) or feebly emarginate (Fig. 35) 3
2. Stigma of forewing higher than wide (Fig. 26); basal vein and cell essentially bare (several setae may be present on basal vein); propodeum narrowed medially to ca. $\frac{1}{3}$ length of plica (Palearctic) *colon* (Linnaeus)
- Stigma of forewing wider than high (Fig. 27); basal vein and cell with some setae; propodeum medially at least $\frac{2}{3}$ length of plica (Holarctic) *aponius* (Walker)
3. Flagellomeres 1 and 2 as long or longer than eye height or scape (each 3 to 4× longer than broad); upper epimeron sculptured much as lower (Nearctic) *dendroctoni* (Ashmead)
- Flagellomeres 1 and 2 shorter than eye height or scape (at most 2.5× as long as broad); upper epimeron smooth 4
4. Stigma of forewing wider than length of stigmal vein from marginal vein to top of stigma (Fig. 28) (Palearctic) *wichmanni* Boucek
- Stigma of forewing narrower than length of stigmal vein from marginal vein to top of stigma (Figs. 30, 31) 5
5. Apical free margin of clypeus feebly emarginate (Fig. 35); prepectus not evenly sculptured, dorsally with a shiny, usually pronounced, groove



Figs. 25-35. *Dinotiscus* spp. 25, 29, parastigmal vein of forewing. 26-28, 30-32, stigma and stigmal vein of forewing. 33-35, apical free margin of clypeus.

- paralleling top border, surface of prepectus irregular, not in single plane (Nearctic) *thomsoni* (Crawford)
- Apical free margin of clypeus straight (Fig. 33); prepectus evenly sculptured and essentially in same plane (Holarctic) *eupterus* (Walker)

Dinotiscus colon (Linnaeus)
(Figs. 25, 26, 34)

Sphex colon Linnaeus, 1758:571.
Dinotus calcaratus Thomson, 1878:40, ♀.

Discussion.—*Dinotiscus colon* shares the deeply emarginate clypeus with *aponius* from which it may be separated by characters in the key. Females of *colon* tend to have an elongate abdomen which is about 3 times as long as the thorax, whereas in *aponius* the abdomen is at most twice as long. Additionally in *colon* the parastigma proximally forms a right angle with the submarginal vein (Fig. 25), but in *aponius* it gradually merges with the submarginal vein (Fig. 29).

Unfortunately the infumate spots associated with the wing veins are so variable (even among a few specimens) as to be of little practical use. If developed, *colon* has a spot at the parastigma and *aponius* does not.

Material examined.—I have seen 4 specimens of this species from Europe.

Distribution.—Britain, Sweden, Finland, Germany, and Czechoslovakia (Graham, 1969).

Hosts.—Reared from Scolytidae as follows: *Tomicus piniperda* (Linnaeus), *T. minor* (Hartig), and *Ips acuminatus* Gyllenhal (Hedqvist, 1963; reported as *Dinotiscus calcaratus*).

***Dinotiscus aponius* (Walker)**

(Figs. 27, 29)

Hetroxys aponius Walker, 1848:127, 215, ♂, ♀. Lectotype ♂, BMNH [examined]. *Pteromalus capitatus*; Ratzeburg, 1848:196, pl. 3, fig. 7. (? misidentification of *capitatus* Foerster, 1840).

Pteromalus patellatus Ratzeburg, 1848:196.

Dinotus bidentulus Thomson, 1878:39, ♂, ♀.

Discussion.—Graham's (1969:411) citation of *Pteromalus capitatus* as being described by Ratzeburg (1848) is in error. Ratzeburg correctly cited the specific name as "32. *P. capitatus* Först. (T. III. F. 7.)." However, under this species name, Ratzeburg suggested that his specimens might represent a new species in which case he proposed the name *patellatus*; the description and diagnosis validate this name. According to Graham (1969:411), the illustration in Ratzeburg (T. III. F. 7.) probably refers to what is currently called *Dinotiscus aponius* (Walker) and I agree with this assessment. The wing venation is fairly diagnostic for the species. As the specimens which Ratzeburg saw are presumably destroyed, the association of names is provisional.

For comparative comments on this species see the key and discussion section for *D. colon*. *Dinotiscus aponius* is apparently widespread in Europe and is reported for the first time in the Nearctic as a possible parasite of the smaller European elm bark beetle (see hosts).

Material examined.—Forty-four Palearctic specimens (BMNH, USNM) determined by Ruschka and Boucek; 3 female specimens from Detroit, Michigan determined by Burks and confirmed by me. These latter specimens represent the only record for this species in the Nearctic.

Distribution.—Northwestern and Central Europe (Graham, 1969), Japan (Kamijo, 1981), and Michigan, U.S.A.

Hosts.—As summarized by Graham (1969), *D. aponius* in Europe attacks scolytids as follows: *Scolytus rugulosus* Ratzeburg, *S. multistriatus* (Marsham), *S. ratzeburgi* Jansson, and *Hylesinus varius* (Fabricius) (reported as *fraxini* Panzer). In the Nearctic, this species has been reared from elm infested with *Scolytus multistriatus* (8 May 1973). According to Kamijo (1981) *aponius* appears to attack scolytids on broad-leaved trees.

***Dinotiscus dendroctoni* (Ashmead)**

(Fig. 32)

Cecidostiba dendroctoni Ashmead, 1874:337, ♀. Lectotype ♀, herein designated, USNM.

Cecidostiba burkei Crawford, 1912:170, ♀. Holotype ♀, USNM [examined]. New synonymy.

Discussion.—Ashmead's *dendroctoni* was described from an unspecified number of "specimens" in the U.S. National Museum. In the museum there are 3 specimens with red type labels. According to the type catalog, 2 specimens were

originally logged as "types" in 1894 and a 3rd was labeled "type" by Gahan in 1928. As the species has had no official "type" designation, I have selected as lectotype 1 of the 2 specimens originally registered in the type catalog. This specimen has the head, wing, and antennae mounted on a slide. The specimen labeled by Gahan as the 3rd type is one of a series on 9 pins (some with multiple specimens) all bearing similar labels stating "Check list No. . . . , Det. by" These may or may not actually have been examined by Ashmead and their status is questionable. Whatever the status of these specimens, 2 were taken from the series by Crawford (1912) and described as *Cecidostiba ashmeadi* which is a synonym of *D. eupterus*. All the other specimens are *eupterus* as well.

Crawford (1912) separated his species *burkei* from Ashmead's *dendroctoni* based upon the supposedly longer postmarginal vein of the former. He had only the holotype female for measurement. I have measured this specimen and the postmarginal is $1.3\times$ the marginal, while in the lectotype of *dendroctoni* it is $1.2\times$. In a reared series of 10 females from Colorado, the postmarginal ranges from 1.2 to $1.4\times$ the marginal and *burkei* easily falls within this range. I consider them to be synonyms, especially based upon the following autapomorphies which define the species: the flagellomeres are all much longer than wide (ca. 3 to $4\times$), with F1 and F2 together longer than either the scape or the eye height (in other *Dinotiscus* F1 and F2 are shorter than the eye height or scape, and each flagellomere is rarely up to $2.5\times$ longer than wide); the upper and lower epimeron are similarly sculptured (upper epimeron polished in other species); and the last tergum is longer than the postmarginal vein (noticeably shorter in other species). I have seen a few specimens from Mexico (Chapingo; Coatepede) which agree with the above, but the upper epimeron is sculptured only medially and is polished around this area. These are the only specimens of *Dinotiscus* known from south of the United States. I think additional specimens are needed to assess their status in relation to typical *dendroctoni*.

Material examined.—In addition to the type series I have seen 80 specimens of *dendroctoni*.

Distribution.—This species has been reported from British Columbia south to New Mexico, Texas (and possibly Mexico), and east to Virginia (Burks, 1979).

Hosts.—*Dinotiscus dendroctoni* is known from the following hosts (Burks, 1979): *Cylindrocopturus furnissi* Buchanan, *Dendroctonus brevicornis* LeConte, *D. rufipennis* (Kirby), *D. frontalis* Zimmermann, *D. ponderosae* Hopkins, *D. pseudotsugae* Hopkins, *Ips grandicollis* (Eichhoff), and *Polygraphus rufipennis* (Kirby). The specimens from Mexico were associated with *Pinus montezumae*.

Dinotiscus wichmanni Boucek

(Fig. 28)

Dinotiscus wichmanni Boucek, 1967:635-636, ♀, ♂.

Discussion.—This species closely resembles *eupterus* and differs primarily by the enlarged stigma (stigma wider than length of stigmal vein in *wichmanni* but narrower in *eupterus*, cf. Figs. 28 and 30).

Material examined.—Forty-eight specimens from Yugoslavia, identified by Boucek (BMNH).

Distribution.—Austria (Boucek, 1967) and Yugoslavia.

Hosts.—Known from *Hylastinus obscurus* (Marsham) (Scolytidae) on *Cytisus laburnum* Linnaeus and *Viburnum lantana* Linnaeus, and from *Hylastinus frankhauseri* Reitter on *Cytisus*.

***Dinotiscus thomsoni* (Crawford)**

(Figs. 9, 10, 31, 35)

Cecidostiba thomsoni Crawford, 1912:171, ♀, ♂. Lectotype ♀, herein designated, USNM.

Discussion.—This species was described from “6 female and 6 male specimens selected from a large series” now housed in the U.S. National Museum. From among these, I have designated a female as lectotype. *Dinotiscus thomsoni* is somewhat aberrant by virtue of its modified prepectus (i.e., fairly irregular in surface contour and sculpture, with a smooth groove paralleling the dorsal margin) and its slightly emarginate clypeus. Also, the stigma is produced angularly on the inner ventral margin (Fig. 31) which is generally characteristic for the species. The toruli are situated above the ventral margins of the eyes by a distance about 1.5 times their own diameter which is an additional character to separate *thomsoni* from *eupterus* (situated less than own diameter above ventral eye margin).

Material examined.—In addition to the type series I have seen about 60 specimens of this species.

Distribution.—So far restricted to the northwestern United States.

Hosts.—*Dinotiscus thomsoni* is known from *Pissodes* sp. (Curculionidae), *Phloeosinus* sp. (new record), and *Scolytus ventralis* LeConte (Scolytidae).

***Dinotiscus eupterus* (Walker)**

(Figs. 30, 33)

Pteromalus eupterus Walker, 1836a:482, ♀. Lectotype ♀, BMNH [examined].

Pteromalus dimidiatus Walker, 1836b:12, ♀. Lectotype ♀, BMNH [examined].

?*Pteromalus capitatus* Foerster, 1840:21, ♂.

Pteromalus lanceolatus Ratzeburg, 1848:204, ♂, ♀.

Dinotus clypealis Thomson, 1878:40, ♂, ♀.

Dinotus acutus Provancher, 1887:201, ♀. **New synonymy.**

Cecidostiba polygraphi Ashmead, 1894:338, ♀, ♂. Lectotype ♀, herein designated, USNM. **New synonymy.**

Cecidostiba ashmeadi Crawford, 1912:170–171, ♀. Holotype ♀, USNM [examined].

Uriella pityogenis Ishii, 1939:189, ♂, ♀.

Discussion.—Burks (1964) saw the type of *acutus* and stated that *ashmeadi* Crawford was a synonym. I have not seen the Provancher type, but I accept Burks' placement. I have compared the known type material of *polygraphi* Ashmead (2 ♀, 1 ♂ syntypes) with *ashmeadi* Crawford (holotype and paratype) and find them identical. Unfortunately only the paratype of *ashmeadi* is in good enough condition to be of value. I hereby designate the better of the 2 females of *polygraphi* Ashmead as lectotype and have placed a label to this effect on the specimen.

This species and *dendroctoni* are the two most commonly encountered species in the Nearctic. Both are widespread and parasitize numerous scolytid hosts on

coniferous trees. The characters used to separate *eupterus* are given in the key and an additional one is given in the discussion of *thomsoni*.

Material examined.—My concept of this species is based upon an examination of about 80 specimens (USNM, BMNH), the lectotype series of *P. eupterus* (BMNH), and the type series of *C. polygraphi* and *C. ashmeadi* (USNM).

Distribution.—This species is now considered to be Holarctic. The Nearctic distribution includes Nova Scotia and Quebec south to Virginia and along the northern United States to Oregon and California. The Palearctic records include Great Britain, Sweden, Germany, and Central Europe (Graham, 1969), and Japan (Kamijo, 1981).

Hosts.—In the Nearctic this species has been reared from Scolytidae as follows (Burks, 1979): *Dendroctonus ponderosae* Hopkins and *Polygraphus rufipennis* (Kirby). Palearctic hosts include scolytid species in the genera *Polygraphus*, *Phthorophloeus*, *Cryphalus*, *Pityophthorus*, *Pityogenes*, and *Dryocoetes* (Graham, 1969), and *Ips* (Kamijo, 1981).

UNPLACED SPECIES

Dinotus elongatus Ashmead

Dinotus elongatus Ashmead, 1888:175, ♀. Holotype ♀, USNM [examined].

I have examined the single holotype female specimen of this species and it is definitely not a *Dinotiscus*. The pronotum lacks a transverse carina, and the propodeum has a well developed, reticulate nucha. The type is fairly fragmentary, but it should be placed near genera such as *Dinarmus* Thomson or *Heteroschema* Gahan based on the structure of the propodeum.

ACKNOWLEDGMENTS

I wish to thank Don Anderson (Systematic Entomology Laboratory, % U.S. National Museum) for helping with current nomenclature in the Scolytidae and Curculionidae. Zdenek Boucek (Commonwealth Institute of Entomology, British Museum (National History)), Michael Schauff (Department of Entomology, Smithsonian Institution), and Arnold Menke (Systematic Entomology Laboratory, % U.S. National Museum) read the manuscript and offered numerous suggestions for its improvement. Additionally, Mike Schauff prepared the scanning electron micrographs (Figs. 7-12). I thank them for their help.

LITERATURE CITED

- Ashmead, W. H. 1888. On the chalcideous tribe Chiropachides. *Can. Ent.* 20:172-176.
 ———. 1894. Descriptions of new parasitic Hymenoptera. *Trans. Amer. Ent. Soc.* 21:318-344.
 ———. 1904. Classification of the chalcid flies. *Mem. Carnegie Mus.* 1:i-xi, 225-551.
 Berisford, C. W. [undated]. The southern pine beetle: Natural enemies and associated organisms, pp. 30-52, Appendix tables 2, 3. *In*: R. C. Thatcher, J. L. Searcy, J. E. Coster, and G. D. Hertel. U.S. Dept. Agric., For. Ser., Sci. Educ. Admin. Tech. Bull. 1631, 267 pp.
 Boucek, Z. 1967. New reared palearctic Pteromalidae. *Acta Ent. Mus. Nat. Pragae* 37:635-647.
 Britton, W. E. 1920. The white pine weevil. Nineteenth report of the state entomologist for 1919. *Bull. Conn. Agric. Exp. Sta.* No. 218:144-155.
 Burks, B. D. 1964 (1963). The Provancher species of Chalcidoidea. *Can. Ent.* 95:1254-1263.
 ———. 1979. Pteromalidae, pp. 768-835. *In*: K. V. Krombein *et al.*, eds., *Catalog of Hymenoptera*

- in America north of Mexico. Vol. I. Symphyta and Apocrita (Parasitica). Smithsonian Institution Press, Washington, D.C., 1198 pp.
- Crawford, J. C. 1912. Descriptions of new Hymenoptera No. 5. Proc. U.S. Natl. Mus. 43:163-188.
- Foerster, A. 1840. Beitrage zur Monographie der Pteromalinen, Nees. 1 Heft. Aachen, 47 pp., 1 pl.
- . Hymenopterologische Studien. 2 Heft. Chalcididae und Proctotrupii. Aachen, 152 pp.
- Gahan, A. B. 1924. Some new parasitic Hymenoptera with notes on several described forms. Proc. U.S. Natl. Mus. 65:1-23.
- Ghesquiere, J. 1946. Contribution a l'etude des Microhymenopteres du Congo belge. X-XI. Rev. Zool. Bot. Afr. 39:367-373.
- Girault, A. A. 1916. New miscellaneous chalcidoid Hymenoptera with notes on described species. Ann. Ent. Soc. Amer. 9:291-308.
- Graham, M. W. R. de V. 1969. The Pteromalidae of Northwestern Europe. Bull. Brit. Mus. (Nat. Hist.). Ent. Suppl. 16:1-908.
- Hedqvist, K. J. 1963. Die Fiende der Borkenkafer in Schweden. I. Erzwespen (Chalcidoidea). Stud. forestal. suec. no. 11:1-176.
- Ishii, T. 1939. New chalcidoid and proctotrypoid wasps reared from forest insects by Dr. H. Kono. Kontyu 13:187-191.
- Kamijo, K. 1981. Pteromalid parasites of bark beetles from Japan, with descriptions of three new species. Kontyu 49:86-95.
- Linnaeus, C. 1758. Systema naturae (10th ed.). Vol. 1. Stockholm, 824 + iii pp.
- McGugan, B. M., and H. C. Coppel. 1962. A review of the biological control attempts against insects and weeds in Canada. Part II. Biological control of forest insects, 1910-1958. Inst. Biol. Contr. Comm. Trinidad, Tech. Comm. No. 2:35-216.
- Moser, J. C., R. C. Thatcher, and L. S. Pickard. 1971. Relative abundance of southern pine beetle associates in East Texas. Ann. Ent. Soc. Amer. 64:72-77.
- O'Brien, C., and G. J. Wibmer. 1982. Annotated checklist of the weevils (Curculionidae *sensu lato*) of North America, Central America, and the West Indies. Mem. Amer. Ent. Inst. 34:i-ix, 1-382.
- Overgaard, N. A. 1968. Insects associated with the southern pine beetle in Texas, Louisiana, and Mississippi. J. Econ. Ent. 61:1197-1201.
- Provancher, L. 1887-1888. Chalcidides, pp. 184-211 (1887), pp. 406-407 (1888). Additions et corrections au volume II de la Faune Entomologique du Canada. C. Darveau, Quebec, 477 pp.
- Ratzeburg, J. T. C. 1844a. Die Forst-Insecten. 3. Berlin, viii + 314 pp., 16 pls.
- . 1844b. Die Ichneumoniden der Forstinsecten in entomologischer und forstlicher Beziehung. 1. Berlin, 224 pp., 4 pls.
- . 1848. Die Ichneumoniden der Forstinsecten in entomologischer und forstlicher Beziehung. 2. Berlin, vi + 238 pp., 4 tables, 3 pls.
- Thomson, C. G. 1878. Hymenoptera Scandinaviae. 5. *Pteromalus* (Svederus) continuatio. Lund, 307 pp., 1 pl.
- Walker, F. 1836a. Monographia Chalciditum. Ent. Mag. 3:465-496.
- . 1836b. Monographia Chalciditum. Ent. Mag. 4:9-23.
- . 1848. List of the specimens of hymenopterous insects in the collection of the British Museum. Part II. Chalcidites. Additional species. London, iv + 237 pp.
- Wood, S. L. 1982. The bark and ambrosia beetles of North and Central America, a taxonomic monograph. Great Basin Nat. Mem. No. 6:1-1359.

A New Species of *Bembix* from Lower California (Hymenoptera: Sphecidae)

TERRY L. GRISWOLD

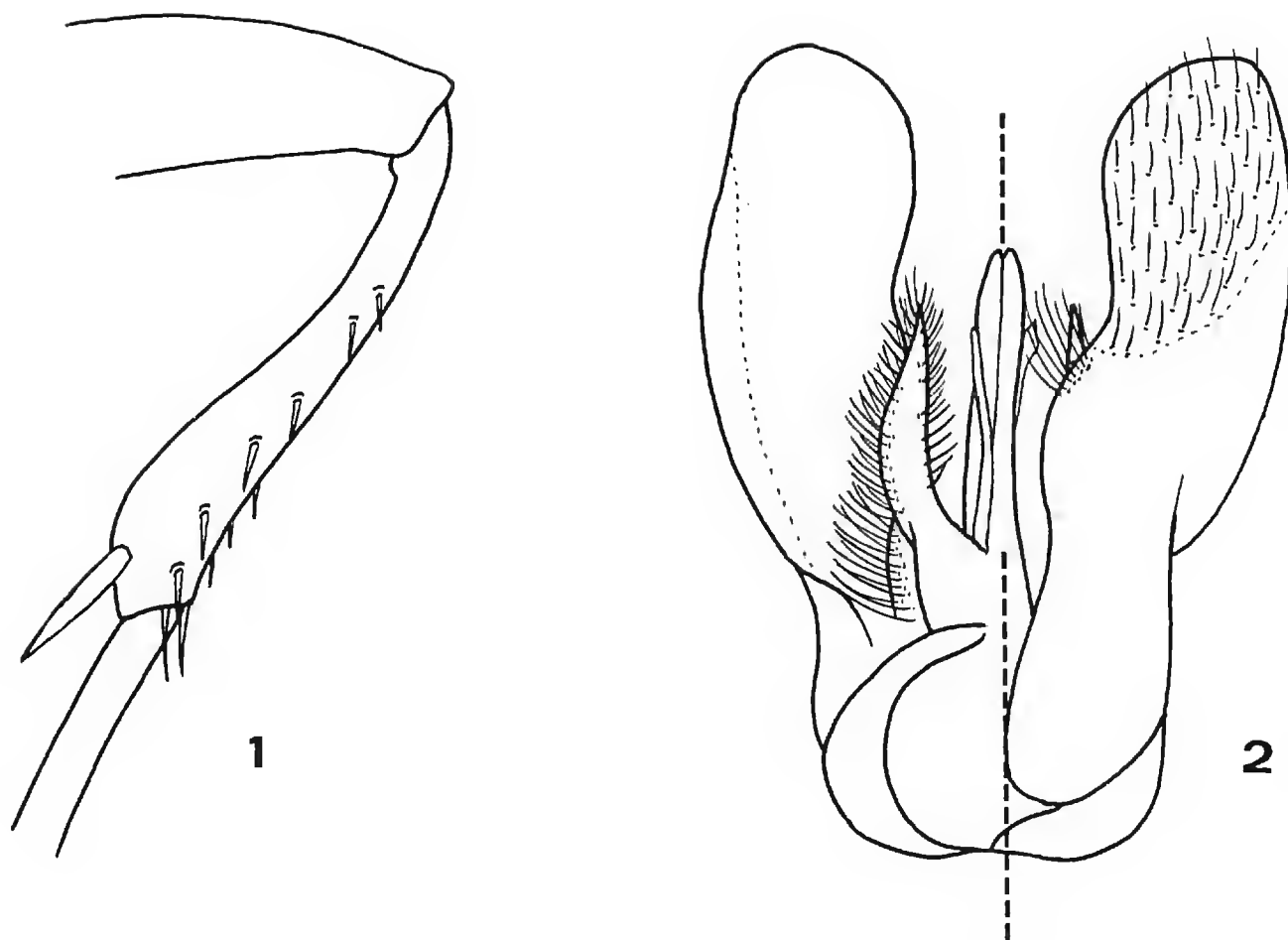
USDA Bee Biology and Systematics Laboratory, Utah State University, Logan,
Utah 84322.

A collection of aculeate Hymenoptera obtained by William H. Clark and his associates during ecological studies in central Lower California was received for identification. Among this material was an undescribed species of *Bembix* Fabricius which is here named after Richard M. Bohart, in recognition of his contribution to the taxonomy of Bembicini.

Bembix boharti Griswold, NEW SPECIES (Figs. 1, 2)

Male.—Length, 22 mm; forewing length, 14 mm. Black with extensive yellow markings, except white postocularly, laterally on scutellum, medially on terga I–V; pale markings as follows: scape; pedicel ventrally; lower half of frons with linear extension dorsally along eye margin to level of midocellus, linear vertical mark below midocellus; clypeus; labrum; mandible except teeth; posterior margin of eye; pronotum except large quadrate dorsal mark and irregular mark at pronotal angle; anterior half of tegula; anterior half of costal lamella; posterolateral corner of scutum; mark on mesopleuron, vertical on upper half of sclerite then obliquely angled ventrally toward anterior margin; basalar area of mesopleuron; basalar lobe of metapleuron; most of metapleuron; lateral portion of propodeum; mesosternum medial to midcoxa; legs except coxae basally, trochanters dorsally, femora at extreme base and central posterior region; tergum I with transverse mark broadly interrupted medially; tergum II–V with transverse mark narrowly interrupted medially, submedially emarginate anteriorly; tergum VI with transverse mark narrowly interrupted medially; tergum VII apically; sternum I except basal inverted “W”-shaped area; sternum II except linear basomedial line and anterolateral corner; sternum III–V basomedially, anterolaterally; basal third of sternum VI; basal two-thirds of sternum VII; medial mark on dorsal surface of paramere. Wings hyaline; veins reddish except subcosta black basally to junction with basal vein. Body clothed with dense, silvery pubescence.

Midocellus a linear crescent; flagellomeres IV–VII with teeth, those on articles VI, VII spinose; flagellomeres IV–X with tyloids; flagellomeres VIII–X expanded ventrally, broader than preceding segments; flagellomere XI elongate, curved; scape length greater than clypeal height; labrum without median angulation, length more than twice clypeal height; mandible slightly curved apically, inner tooth distinct; forebasitarsus with 7 rake setae; midfemur with small denticles ventrally on apical four-fifths; midtibia with ventral flange on apical half (Fig. 1); length of midtibial spur less than one-half length of midbasitarsus; first intersubmarginal vein of forewing with strong, step-like double bend; tergum VII broadly rounded apically, without lateral angle; spiracular lobe broad, rounded apically, length one-



Figs. 1, 2. *Bembix boharti*. 1, Portion of male midleg showing distally enlarged tibia. 2, Male genital capsule (left side, ventral view; right side, dorsal view).

half that of tergum VII; sternum II with prominent, blunt, median keel; sternum VI with broad, ventrally flattened median process notched apically, ventral surface parallel to surface of sternum; sternum VII with submedian longitudinal carina in addition to apically notched median carina; genitalia as in Fig. 2.

Female.—Length, 19–21 mm; forewing length, 13–14 mm. Markings as in male except: white markings reduced to medial areas of terga I–IV; pale markings of pronotum more extensive; scutum with anterolateral and discal stripes; mesopleural mark expanded posteroventrally to form rough triangle, mesopleuron with additional narrowly isolated mark dorsoposteriorly; metapleuron entirely pale; propodeum with lateral mark expanded to posterior face, additional marks along posterior margin of propodeal triangle; terga II and sometimes III with markings expanded anteriorly forming small enclosed black spots; tergum VI yellow except basally; pale markings of sternum I expanded; sternum II pale except for oval basomedial area; sternum VI pale except for narrow medial line; wing venation darker.

Structures as in male except flagellomeres, midfemur, midtibia, sterna not modified; ratio of maximum length of flagellomere I to maximum length of scape between 1.04 and 1.11; ratio of length of flagellomere I to height of clypeus between 1.22 and 1.34; forebasitarsus with 7 rake setae, length of distal ones more than twice width of basitarsus; pygidium slightly roughened, without lateral angle.

Type material.—Holotype ♂, MEXICO, *Baja California (Norte)*, 9 km NW Rancho Santa Inés, 29°46'N, 114°46'W, 10-VI-79, W. H. Clark. Paratypes: MEXICO: *Baja California (Norte)*: 12 ♂, 7 ♀, same data as holotype; 1 ♂, 2 ♀, same

except 11-VI-79; 1 ♀, same except 14-VI-79; 1 ♂, 2 ♀, same except 17-VI-79; 1 ♀, same except 19-VI-79; 6 ♂, 20 ♀, same except E. R. Tinkham; 1 ♀, same except 11-VI-79, J. Hoch; 1 ♀, same except 12-VI-79; 1 ♂, 1 ♀, 9.6 km (6 mi) NW Rancho Santa Ines, 29°43'N, 114°43'W, 17-VI-79, J. Miles; 1 ♀, 1.6 km (1 mi) NE Santa Catarina Ranch, 29°44'N, 115°09'W, 20-VI-79, W. H. Clark; 1 ♀, 8 km NW Santo Tomas, 31°37'N, 116°27'W, 200 m, 9-VI-79, W. H. & M. H. Clark; 1 ♂, El Marmol, 18-VI-38, Michelbacher & Ross. *Baja California Sur*: 1 ♂, 4 ♀, La Paz and vicinity, 11/14-VI-75, H. E. Evans; 1 ♀, same except H. Evans, W. Rubink, & D. Gwynne; 1 ♂, 1 ♀, Cape San Lucas, 19-III-28, T. Craig; 2 ♀, La Paz, 3-VI-21, E. P. VanDuzee; 1 ♀, same except 4-VI-21; 2 ♀, La Paz, 7.6 m (25'), 12-V-69, S. C. Williams; 2 ♀, 4.8 km (3 mi) W San Miguel de Comondu, 457 m (1500'), 21-IV-69, S. C. Williams. Holotype will be deposited at the California Academy of Sciences, paratypes at the Museum of Natural History, College of Idaho, Caldwell, Idaho, California Academy of Sciences, Colorado State University, University of California at Davis, U.S. National Museum, USDA Bee Biology and Systematics Laboratory, Logan, Utah, and the personal collection of E. R. Tinkham.

Additional material.—MEXICO, *Baja California (Norte)*: 2 ♀, km 76.7 on road to Sierra San Pedro Martir National Park, 21-VII-77, D. Weissman & C. Mullinex; 1 ♀, same except km 76.5, 20-VII-77.

Discussion.—This species belongs to the *amoena* species-group of Evans and Matthews (1968) which contains two other species, *B. amoena* Handlirsch and *B. sayi* Cresson. *B. boharti* is close to *B. sayi*, and given the wide distribution and considerable variation of *B. sayi* it might be questioned whether *B. boharti* is distinct. However, I have studied 56 males and 51 females of *B. sayi* from throughout its range and find there to be distinct and consistent differences between the two species. Further, the range of *B. sayi* extends westward into California only in the northern Mojave Desert, not entering either the Colorado Desert or cismontane southern California. Thus, *B. boharti*, which appears to be restricted to central and southern Lower California, is isolated from *B. sayi* by these intervening regions. The male of *B. boharti* runs to couplet 9 in Evans and Matthews' key. It can be separated from the other two species in this group by the strong, apically expanded ventral keel on the midtibia, the absence of a polished basal welt on flagellomere XI, and the more evenly rounded apicolateral margin of the paramere. It also differs from *B. amoena* in the short midtibial spur (less than half length of midbasitarsus) and the broad spiracular lobe of tergum VII, and from *B. sayi* by the median platform of sternum VI parallel to the surface of the segment and sternum VII with strong lateral carinae. Males of *B. boharti* vary slightly in the extent of the pale markings. Some possess faint white discal marks on the scutum.

The female of *B. boharti* is easily distinguished from *B. amoena* by the short midtibial spur (less than half length of midbasitarsus). It runs to *B. sayi* in the key of Evans and Matthews (1968). The only consistent difference found between female *B. boharti* and *B. sayi* is in the length of flagellomere I relative to the maximum scape length (Fig. 3). The ratio of these lengths is greater in *B. boharti* (flagellomere I length/maximum scape length: $\bar{x} = 1.07 \pm 0.02$, range = 1.04–1.11, $n = 54$) than in *B. sayi* ($\bar{x} = 0.96 \pm 0.03$, range = 0.86–1.00, $n = 51$). Note that the ranges of the ratios do not overlap. A Mann-Whitney U Test comparing the ratios of these two species was significant ($P < 0.0001$). The length of flagello-

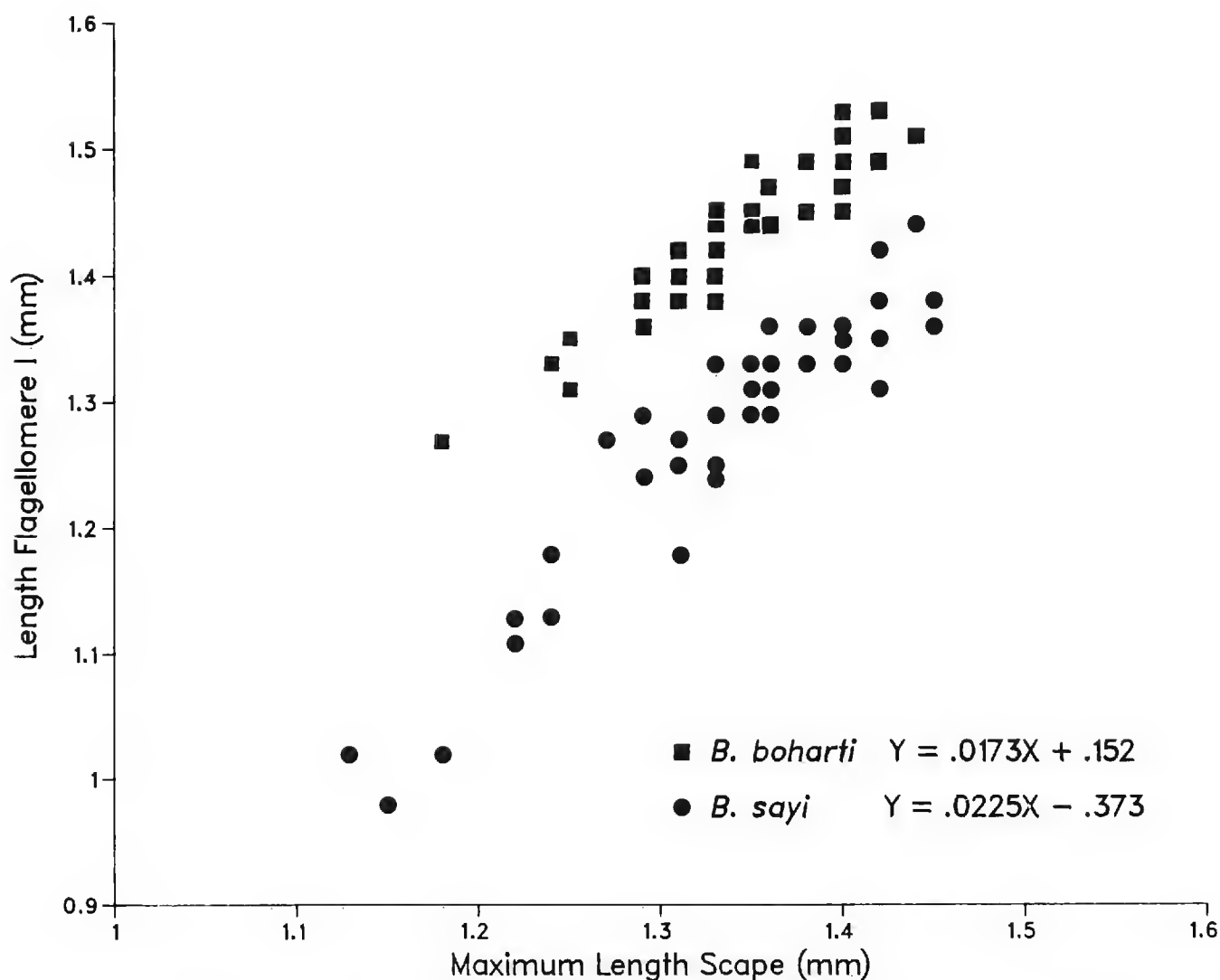


Fig. 3. Plot of length of flagellomere I against maximum scape length for female *B. boharti* and *B. sayi*.

mere I in relation to the height of the clypeus is also usually greater in *B. boharti* (flagellomere I length/median clypeal height: $\bar{x} = 1.27 \pm 0.03$, range = 1.22–1.34, $n = 54$) than in *B. sayi* ($\bar{x} = 1.10 \pm 0.06$, range = 0.97–1.22, $n = 51$). A Mann-Whitney U Test comparing these ratios was also significant ($P < 0.0001$). An additional character that will serve to differentiate most specimens is the absence of a complete longitudinal black stripe on the venter of the abdomen and the presence of a fine medial black line on sternum VI. However, specimens of *B. boharti* from near Sierra San Pedro Martir National Park have the black areas more extensively developed and occasional specimens of both *B. sayi* and *B. amoena* have reduced black areas approaching the condition of *B. boharti*.

Evans (1976) recorded *B. sayi* from Baja California Sur, described aspects of its nesting biology, and commented that it differed from populations at several locations in the United States in its "mound-building behavior." I have studied these specimens and find them to be representatives of *B. boharti*. Thus, the differences in nesting biology noted by Evans may be of species significance. Fox (1923) also recorded *B. sayi* from Lower California. These records also refer to *B. boharti*.

ACKNOWLEDGMENTS

I wish to thank William Clark, Museum of Natural History, College of Idaho, Caldwell, Idaho; Wojciech Pulawski, California Academy of Sciences; Howard

Evans, Colorado State University; Richard Bohart, University of California at Davis; and Ernest Tinkham, Indio, California for the loan of material, Frank Parker for reviewing the manuscript, and Vincent Tepedino for assistance with statistical details.

LITERATURE CITED

- Evans, H. E. 1976. Bembicini of Baja California Sur: Notes on nests, prey, and distribution. Pan-Pac. Ent. 52:314-320.
- Evans, H. E., and R. W. Matthews. 1968. North American *Bembix*, a revised key and suggested grouping. Ann. Ent. Soc. Amer. 61:1284-1299.
- Fox, C. L. 1923. Expedition of the California Academy of Sciences to the Gulf of California in 1921. The Bembicini (digger wasps). Proc. Calif. Acad. Sci. (4)12:429-436.

Three New Species of New Zealand Tardigrades (Tardigrada: Echiniscidae)

DONALD S. HORNING, JR. AND ROBERT O. SCHUSTER

(DSH) Macleay Museum, University of Sydney, New South Wales 2006, Australia; (ROS) Department of Entomology, University of California, Davis, California 95616.

Professor Walter Maucci (pers. comm.) indicated that the identification of *Pseudechiniscus lateromamillatus* Ramazzotti (1964) in Horning, Schuster and Grigarick (1978) was in error. A re-examination of the New Zealand specimens considered to be variants of *P. lateromamillatus* led to the recognition of three undescribed species.

We have retained these new species in *Pseudechiniscus*. The pseudosegmental area of these species is too large for *Echiniscus* and hardly large enough for *Pseudechiniscus*. These species could be placed in either genus, or a new genus. The problem is confounded by questionable illustrations of named species and the lack of a comparative study of the morphology of this part of the family. Eye pigment is lacking, probably due to the fixation procedures.

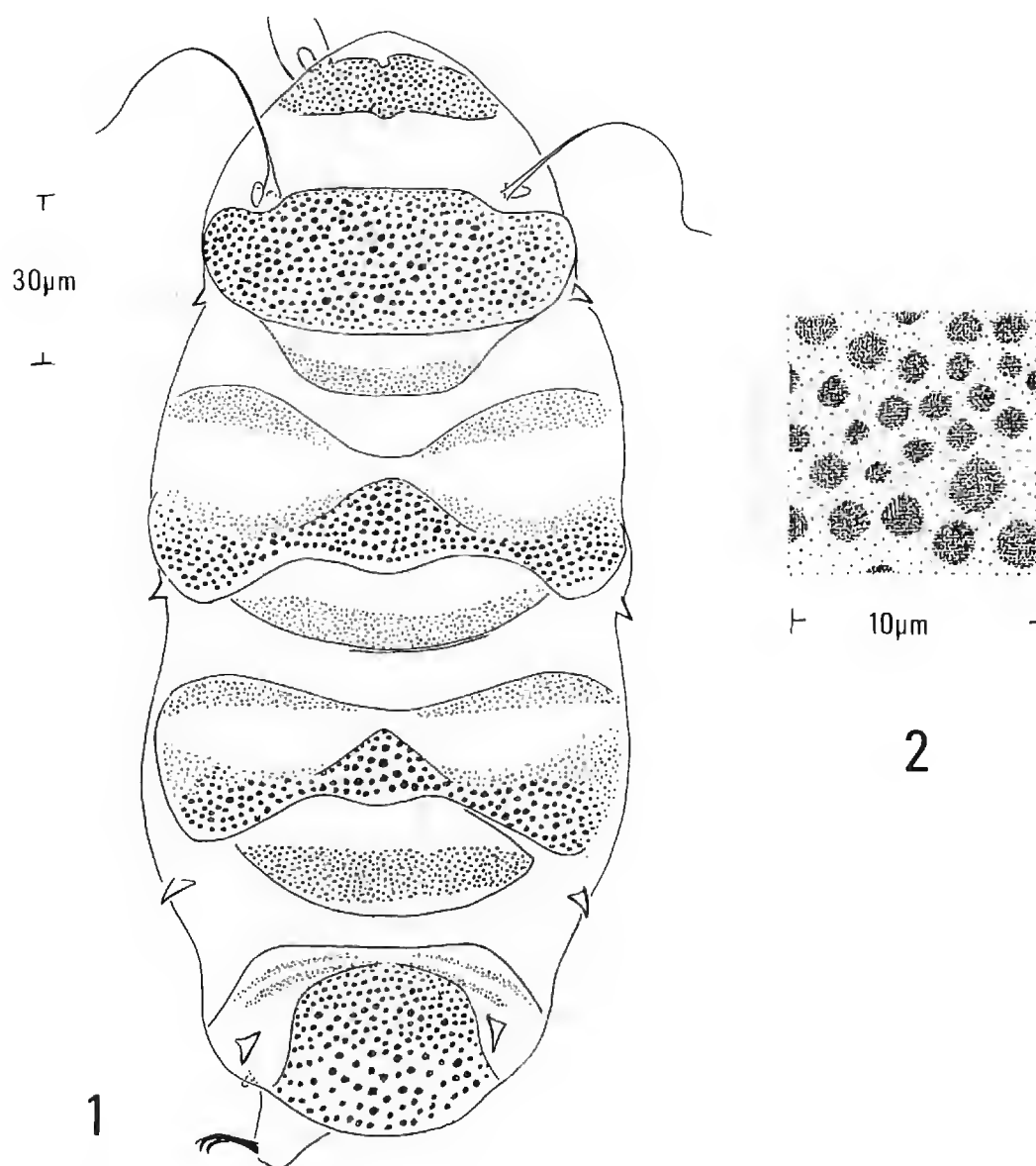
The holotypes of the three new species are deposited in the National Museum of New Zealand, Wellington (NMNZ). Paratypes are deposited in NMNZ and the Department of Entomology Museum, University of California, Davis (UCD). The number of paratypes from any sample is given parenthetically following the NZ sample number. The sample numbers and their associated data have been listed previously (Horning *et al.*, 1978) and, unless otherwise noted, the collector was D. S. Horning, Jr.

We dedicate this article to R. M. Bohart, our mentor for many years, on the occasion of his 70th birthday.

Pseudechiniscus conversus Horning and Schuster, NEW SPECIES (Figs. 1, 2)

Length of dorsum excluding legs IV 188.5 μm ; including legs IV 203 μm . Cuticle with granular pattern; granules largest (1.3–2.5 μm diameter) on scapular plate, median line and posterior margins of plates C and D, and terminal plate; granulation of head plate slightly smaller, and of posterior of third median still smaller; remaining areas (stipple of Fig. 1) with granule diameter 0.3–0.4 μm ; very infrequent light spots (pores) randomly distributed. Head with simple buccal cirri, interior 9.5 μm long, exterior 19 μm ; buccal papilla 6 μm long, 4 μm wide; eye pigment absent. Scapular plate with cirrus A 52 μm long, clava 6 μm long, 3 μm wide. Lateral spines present at positions B, C, D and E, short, triangular, about 6 μm long. Leg I spine bluntly conical, 2.9 μm long; leg IV papilla 3.3 μm long; inner claws of all legs with basal spur.

Discussion.—This species was the basis for the misidentification of *P. lateromamillatus* Ramazzotti in Horning *et al.* (1978). It fits the description of that



Figs. 1, 2. *Pseudechiniscus conversus*. 1, dorsal aspect. 2, detail of scapular cuticle.

species, but examination of a paratype revealed that *lateromamillatus* has pores instead of granules as the major cuticular feature.

The cuticular pattern of diversely sized granules, the largest occurring in precisely limited areas, and the near absence of pores are the most obvious recognitional features of this species.

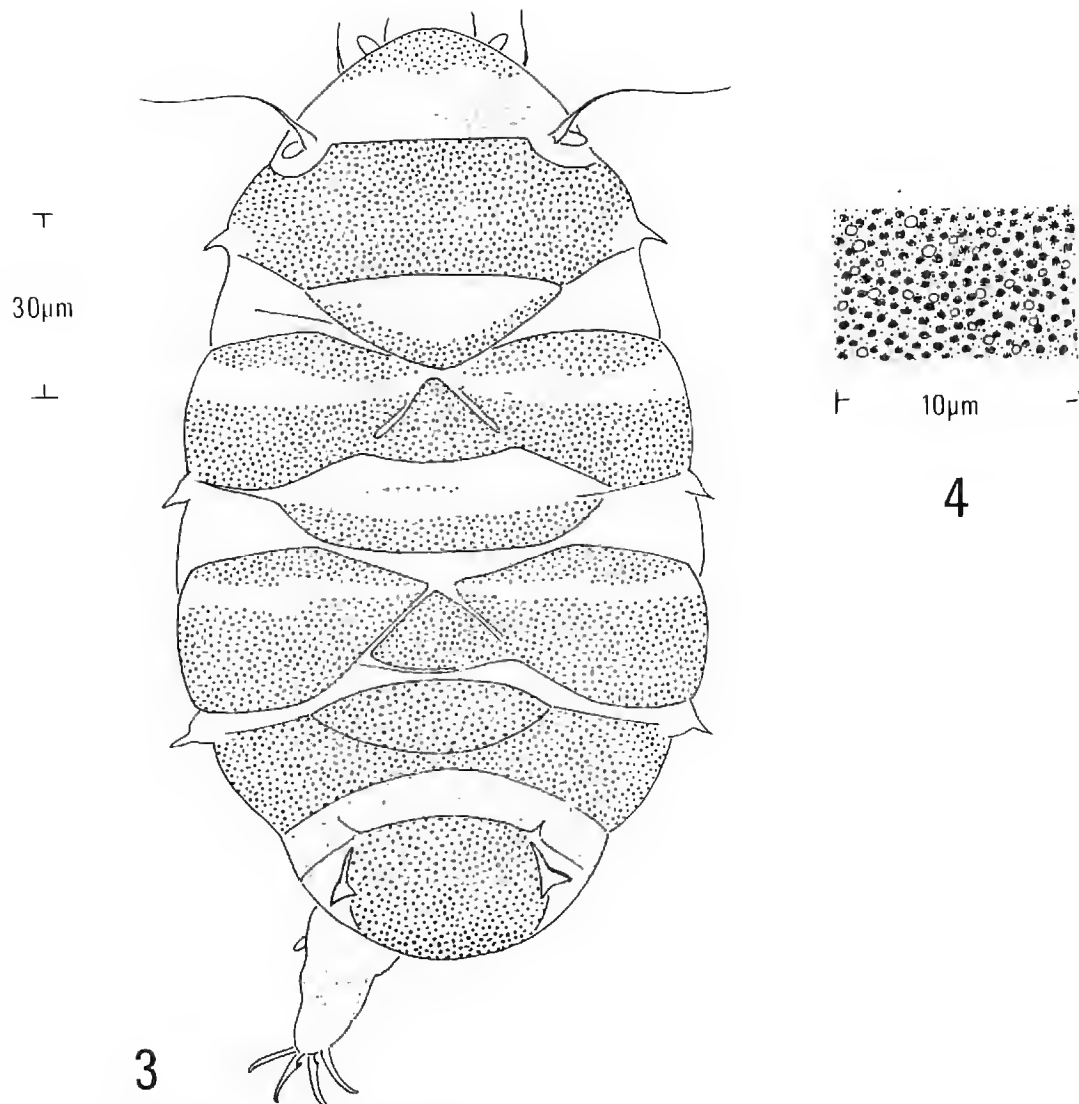
Etymology.—Latin: *conversus*, opposite; noting the reverse of cuticular characteristics distinguishing the species from *P. lateromamillatus*.

Types.—Holotype and 1 paratype: *South Island*: Canaan Road Terminus, Abel Tasman National Park, 9-IV-1971, NZ 525 (holotype) (NMNZ—Arthropoda 10/32) and NZ 526 (NMNZ).

Habitat.—The holotype was found on the foliose lichen *Lobaria adscripta* (Nyl.) Hue on live *Nothofagus* sp. in a shaded beech forest. The paratype was found on foliose lichens, mostly *Pseudocyphellaria* spp., on live *Nothofagus* in an open, wind-exposed meadow. The sample contained 11 species of tardigrades, the highest number of species found in 577 New Zealand tardigrade-positive samples.

***Pseudechiniscus parvisentus* Horning and Schuster, NEW SPECIES**
(Figs. 3, 4)

Length of dorsum excluding legs IV 157 μm ; including legs IV 171 μm . Cuticle of dorsal plates consists of granules and pores of generally uniform size; granules



Figs. 3, 4. *Pseudechiniscus parvisentus*. 3, dorsal aspect. 4, detail of scapular cuticle.

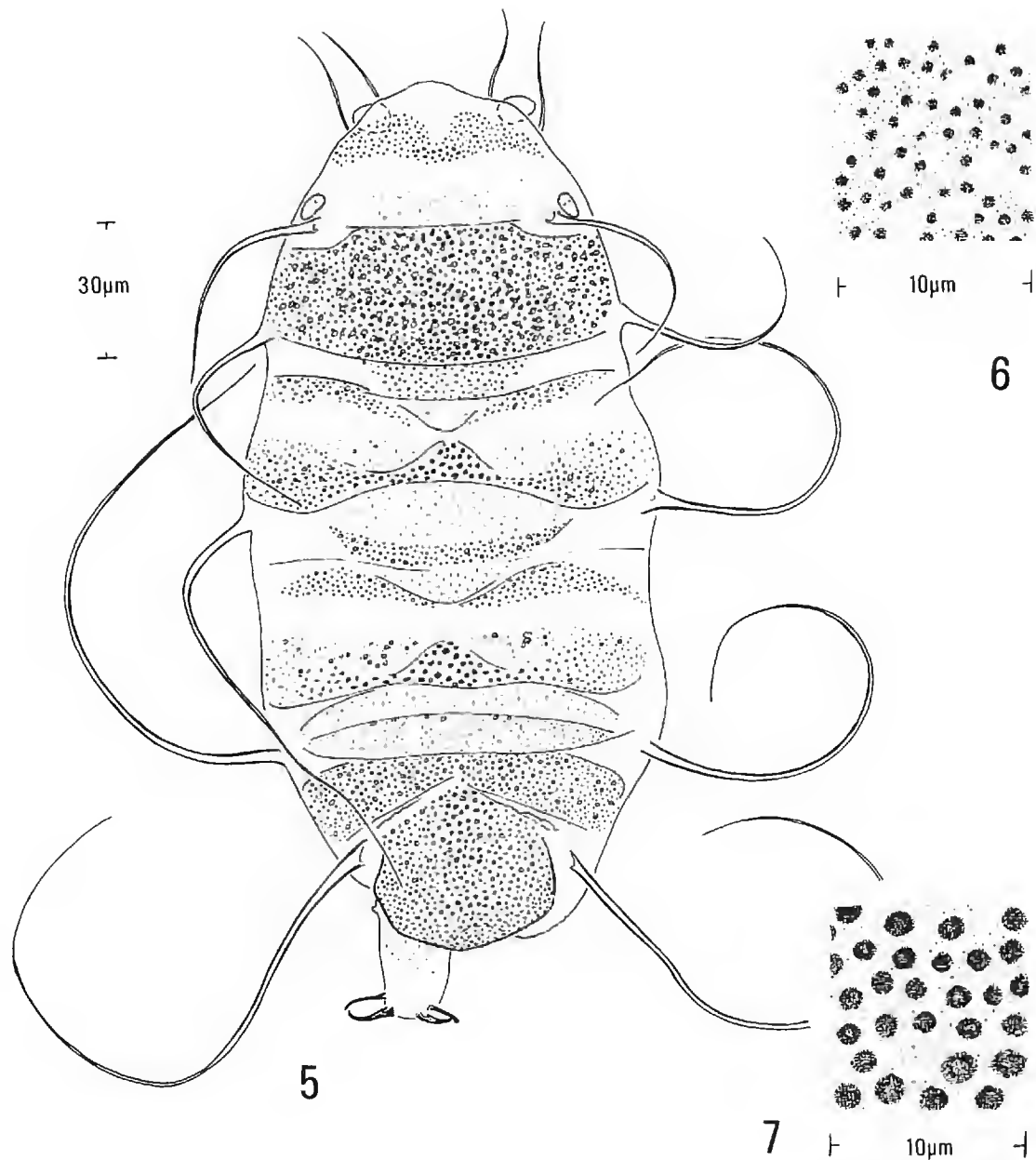
of about $0.3\ \mu\text{m}$ diameter. Head with acuminate buccal cirri; interior cirrus $6.7\ \mu\text{m}$, exterior $10\ \mu\text{m}$ long; buccal papilla $6\ \mu\text{m}$ long, $4\ \mu\text{m}$ wide; eye pigment absent. Scapular plate with cirrus A $33\ \mu\text{m}$ long; papilla $6\ \mu\text{m}$ long, $3\ \mu\text{m}$ wide. Lateral spines $6\ \mu\text{m}$ to $12\ \mu\text{m}$ long, thick at base and tapered distally, present at positions B, C, D and E. Leg I spine minute, about $2\ \mu\text{m}$ long, $1\ \mu\text{m}$ wide; leg IV papilla $3\ \mu\text{m}$ long, $2\ \mu\text{m}$ wide; internal claws of all legs with basal spur.

Discussion.—This species is similar to *P. conversus* in respect to size and arrangement of spines. However, the pattern of the dorsal plates is uniformly of small granules and pores except that along the posterior margin of the terminal plate the granules are slightly larger and pores are infrequent and obscure.

Etymology.—Latin: *parvus*, little; *sentus*, spine; in reference to the short lateral spines.

Types.—Holotype and 5 paratypes: *South Island*: Otepatotu Bush, Banks Peninsula, 3-XI-1970, NZ 392 (holotype) (NMNZ—Arthropoda 10/33), NZ 596 (1, NMNZ). Additional paratypes: *South Island*, West Harpers Hut, 14 km S Bealey, 12-IV-1971, H. A. Best, NZ 539 (1, NMNZ), NZ 544 (1, UCD); Lewis Pass, 11-V-1970, NZ 106 (1, NMNZ); Halpins Creek, Arthurs Pass National Park, 18-V-1970, NZ 149 (2, NMNZ). *North Island*: Mountain House Road, Mt. Egmont National Park, 23-V-1971, NZ 746 (1, NMNZ), NZ 752 (1, NMNZ); Ohakune Scenic Reserve, 21-V-1971, NZ 711 (3, UCD).

Habitats.—All habitats were in wet *Nothofagus* forests. *Pseudechiniscus par-*



Figs. 5-7. *Pseudechiniscus perplexus*. 5, dorsal aspect. 6, detail of scapular cuticle. 7, detail of terminal cuticle.

visentus was found on mosses on trees and shaded rocks (five samples), foliose lichens, *Sticta* spp., on trees (two samples) and one hepatic sample on a tree.

***Pseudechiniscus perplexus* Horning and Schuster, NEW SPECIES**
(Figs. 5-7)

Length excluding legs IV 193 μm , including legs IV 218 μm . Cuticle of dorsal plates consists of granules generally of about 0.6 μm diameter, and frequent larger, randomly spaced pores; granules larger on median line and posterior margins of plates C and D. Head with acuminate buccal cirri, interior 11 μm long, exterior 23 μm long; buccal papilla 9 μm long, 7 μm wide, eye pigment absent. Scapular plate with cirrus A 58 μm long; clava 7 μm long, 5 μm wide. Lateral spines B, C, D, and E present; approximate lengths of B 80 μm , C 140 μm , D 150 μm and E 170 μm . Leg I with acute spine 3 μm long; leg IV papilla about 4 μm long; inner claws of all legs with basal spur.

Discussion.—The dorsal pattern of this species is pronounced in some areas, similar to the pattern of *P. conversus*, and the presence of both granules and pores is similar to the cuticle of *P. parvisentus*.

Etymology.—Latin: *perplexus*, intricate; for the beautifully intricate pattern of bright and dark spots of the cuticle.

Types.—Holotype: *South Island*: Goulard Downs Hut, Heaphy Track, 12-IX-1971, Margaret E. Miller, NZ 1109 (NMNZ—Arthropoda 10/34). Paratypes: *South Island*: Halpins Creek, Arthurs Pass National Park, 12-X-1970, NZ 373 (1, NMNZ); Canaan Road Terminus, Abel Tasman National Park, 9-IV-1971, NZ 526 (2, NMNZ; 3, UCD).

Habitats.—This species was found on foliose lichens, mostly *Pseudocyphellaria* spp., on live trees and shrubs. It was also found with *Pseudechiniscus conversus* (NZ 526).

KEY TO NEW ZEALAND *PSEUDECHINISCUS*

1. Dorsal plates B, C, D and E with lateral spines 2
- Dorsal plates B, C, D and E without lateral spines 4
2. Dorsal plate pattern almost entirely granules, pores infrequent
 *P. conversus* Horning and Schuster, n. sp.
- Dorsal plate pattern of both granules and frequent pores 3
3. Lateral spines short (6 to 12 μm)
 *P. parvisentus* Horning and Schuster, n. sp.
- Lateral spines long (80 to 150 μm)
 *P. perplexus* Horning and Schuster, n. sp.
4. Pseudosegmental plate with simple posterior margin
 *P. s. suillus* (Ehrenberg)
- Pseudosegmental plate with 2 broad, short spines on posterior margin
 *P. n. novaezeelandiae* (Richters)

ACKNOWLEDGMENTS

Professor Walter Maucci kindly arranged the loan of a paratype specimen of *Pseudechiniscus lateromamillatus* from the Istituto Italiano di Idrobiologia, Palanza, and Dr. Diane Nelson examined the specimens and illustrations and critically read the manuscript.

LITERATURE CITED

- Horning, D. S., Jr., R. O. Schuster, and A. A. Grigarick. 1978. Tardigrada of New Zealand. *New Zealand J. Zoo.* 5:185–280.
- Ramazzotti, G. 1964. Tardigradi del Cile, III, con descrizione delle nuove specie *Oreella minor* e *Pseudechiniscus lateromamillatus*. *Atti Soc. Ital. Sc. Nat.* 103:347–355.

The *boharti* Species Group of the Genus *Pherocera* (Diptera: Therevidae: Phycinae)

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INTRODUCTION

The published history of *Pherocera* is meager. The genus was described by Cole (1923a) for three species: *P. albihalteralis* Cole, *P. flavipes* Cole, and *P. signatifrons* Cole, with *P. signatifrons* designated as the type-species. At that time, Cole had available for study only eight female specimens, six of which were *P. signatifrons*. That same year, Cole (1923b) described a fourth species, *Pherocera nigripes* Cole, based on a single female from Mexico. Except for passing mention by Hardy (1927:385), Rodendorf (1964:86), Cole (1965:349), and Cole and Schlinger (1969:170, 172), no reference was made of the genus *Pherocera* until the 1970's.

An important factor in any account of *Pherocera* is its historical rarity in entomological collections. Until the beginning of 1940 only 18 specimens were known to exist in collections, and during the 1940's only 34 were added. After 1952 the number of specimens of this genus increased greatly, due largely to the collecting efforts of Evert I. Schlinger. I became interested in the group and added considerably to the collections between 1963 and 1970. During the 1970's specimens were gathered mainly through the efforts of Saul I. Frommer who maintained a malaise trap in the P. L. Boyd Desert Research Center near Palm Desert, Riverside County, California.

The genus *Pherocera* has a restricted distribution, being confined to western North America. Its northern limit, according to specimens examined, is in Oregon and Idaho; its southern limit is near Puebla, Mexico. It has been collected as far east as Colorado, New Mexico, and western Texas. Its current center of distribution is southern California.

I completed a study of *Pherocera* and its relatives in 1971 (Irwin, 1971) and published a paper on two closely related genera, *Schlingeria* Irwin and *Parapherocera* Irwin, six years later (Irwin, 1977). Previously I published on the comparative morphology of the female terminalia and oviposition behavior in the Therevidae, including a section on *Pherocera* (Irwin, 1976). A review of the Nearctic genera of Therevidae (Irwin and Lyneborg, 1981a) contained a redescription of the genus *Pherocera* and included the following statement (p. 268): "Thirty species of the genus *Pherocera* have been described but not formally published." My dissertation (Irwin, 1971) divided the 34 recognized species of *Pherocera* into seven species groups, one of which included *P. flavipes* and seven additional species. Although designated the "*flavipes* group" in the dissertation, I am renaming it the "*boharti* group" in honor of Richard M. Bohart, mentor and esteemed friend. This paper describes the seven unpublished species of the *boharti* group and updates the description of *P. flavipes*.

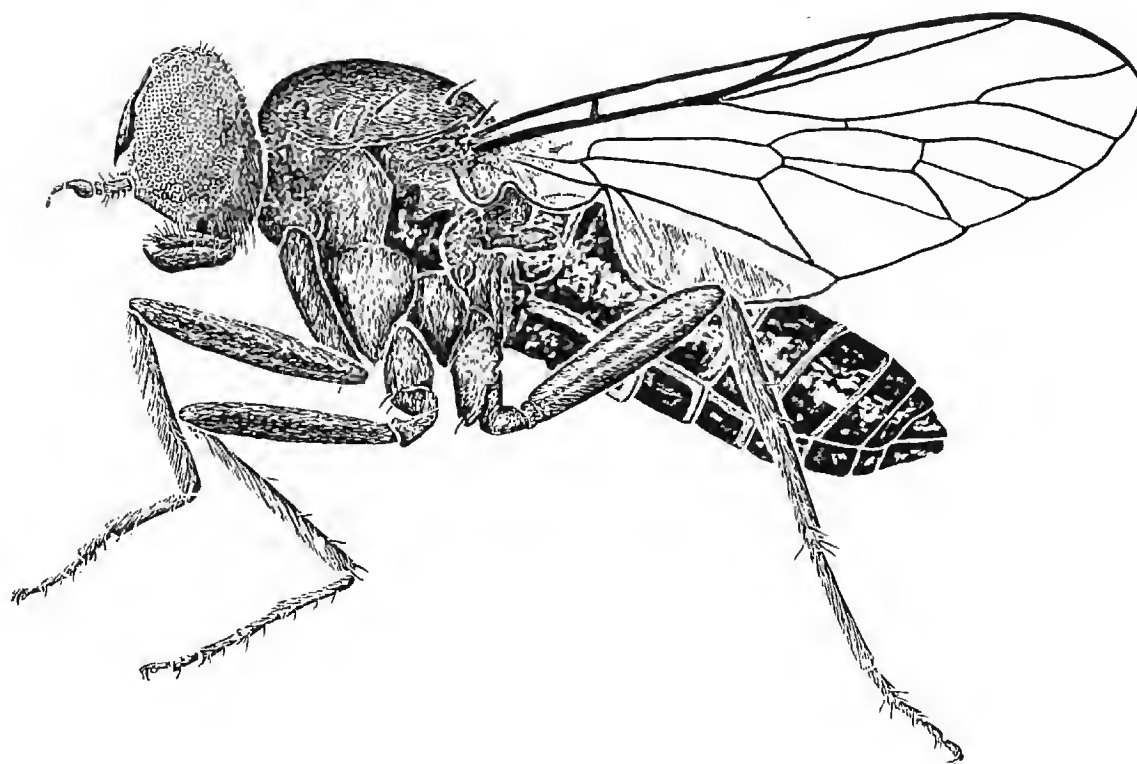


Fig. 1. *Pherocera rupina*, female (1725), lateral view.

ACKNOWLEDGMENTS

Richard M. Bohart, more than any person, bolstered my early interest in insect systematics. I strongly support the efforts of Arnold Menke and Eric Grissell in dedicating this issue of Pan-Pacific Entomologist to Dick for his generous and enriching fellowship. To Dick and his gracious wife, Margaret, I extend heartfelt and eternal gratitude.

I earnestly thank the following for contributing to this manuscript: Evert I. Schlinger, University of California at Berkeley; Saul I. Frommer, University of California at Riverside; Donald W. Webb, David J. Voegtlin, and John K. Bouseman, Illinois Natural History Survey, for critical review of the manuscript; and John P. Sherrod, Illinois Natural History Survey, for drawing Figs. 6–11. The curators of several of the major entomological museums are gratefully acknowledged for loaning valuable material.

Support for this study was supplied in part by a National Defense Education Act Fellowship, the University of California Regents Patent Fund, the University of California Dry Lands Institute, the University of California Deep Canyon Research Fund, the Illinois Natural History Survey, and the University of Illinois.

METHODS AND PROCEDURES

Specimen number.—Each specimen has been assigned a unique number to facilitate the association of data. The number appears below the specimen on a yellow label bearing the following words: THEREVIDAE/M. E. IRWIN/SPECIMEN #. Numbers referring to specimens will not be found in the text even though they have been used to incorporate ecological and label data associated with the specimens into an automated data management system designed by Rauch (1970). These numbers have been associated with individual specimens in the figures, however. If ecological or depository information regarding individual specimens is needed, please contact the author.

Format of "Specimens examined" section.—To conserve space and include as much information about each specimen as possible, the following layout, adopted from Irwin (1977), was used in the "Specimens examined" section under each species. Many of these terms are more fully explained by Stuckenberg and Irwin (1973): 1) **LARGEST POLITICAL UNIT** [country, or state within the United States, in capital letters], 2) **intermediate political unit** [state or province, or county within the United States, in boldface print], 3) **smallest political unit** [city or town in regular print], 4) **modifier of smallest political unit** [distance (km) and direction, or subunit, in regular print], 5) **elevation** [in meters (m) above sea level, in boldface print], 6) year/month/day that the specimen was collected [year expressed by two digits, the "19" has been omitted since all specimens examined were collected in the 1900's], 7) collector(s) [acronym(s), not in parentheses, expanded below], 8) number of specimens of each sex [♂ or ♀], and 9); [a semicolon indicates that data for previous specimens terminate and data for the next series of specimens follow]. If subsequent specimen data are not included, data not repeated are the same as those of preceding specimens.

Collectors.—AFH, Howland, A. F.; ALM, Melander, A. L.; ARG, Gillogly, A. R.; ATM, MacClay, A. T.; CAT, Toschi, C. A.; CTB, Brues, C. T.; DEF, Fox, D. E.; EIS, Schlinger, E. I.; EMP, Painter, E. M.; FDP, Parker, F. D.; FXW, Williams, F. X.; GRB, Balmer, G. R.; HAH, Hunt, H. A.; HKC, Court, H. K.; HRM, Moffit, H. R.; JAP, Powell, J. A.; JCB, Bradley, J. C.; JCD, Downey, J. C.; JCH, Hall, J. C.; JFL, Lawrence, J. F.; JRQ, Quezada, J. R.; JT, Turner, J.; JW, Wilcox, J.; JWM, MacSwain, J. W.; KWB, Brown, K. W.; LAS, Stange, L. A.; LFL, Lapre, L. F.; MEI, Irwin, M. E.; MTJ, James, M. T.; PAR, Rauch, P. A.; PDH, Hurd, P. D.; PHA, Arnaud, P. H.; RAS, Stirton, R. A.; RCB, Bechtel, R. C.; RES, Somerby, R. E.; RHP, Painter, R. H.; RMB, Bohart, R. M.; RMW, Worley, R. M.; SIF, Frommer, S. I.; SL, Larisch, S.; SLF, Frommer, S. L.; WAS, Steffan, W. A.; WI, Icenogle, W.; WJH, Hanson, W. J.; WRM, Mason, W. R.

Depositories.—Specimens from this study have been deposited with the following museums: AMNH, American Museum of Natural History, New York; ANSP, Academy of Natural Sciences, Philadelphia, Pennsylvania; ASU, Arizona State University, Tempe; AMS, Australian Museum, Sydney; BMH, Bernice P. Bishop Museum, Honolulu, Hawaii; BMNH, British Museum of Natural History, London, England; BYU, Brigham Young University, Provo, Utah; CAS, California Academy of Sciences, San Francisco; CIS, California Insect Survey, University of California, Berkeley; CMNH, Field Museum of Natural History, Chicago, Illinois; CMP, Carnegie Museum, Pittsburgh, Pennsylvania; CNC, Canadian National Collection, Ottawa; CSDA, California State Department of Agriculture, Sacramento; CSIR, Commonwealth Scientific Industrial Research Organization, Canberra, Australia; CSU, Colorado State University, Fort Collins; CU, Cornell University, Ithaca, New York; DEI, Deutsches Entomologisches Institut, Berlin, East Germany; DSIR, Department of Scientific and Industrial Research, Nelson, New Zealand; DZSA, Departamento de Zoologia Agricultura, São Paulo, Brazil; EEA, Estación Experimental Agronómica, Universidad de Chile, Maipú; FSCA, Florida State Collection of Arthropods, Gainesville; IAS, Institute of Agricultural Sciences, Tokyo, Japan; IE, Instituto di Entomologia, Bologna, Italy; IML, Instituto Miguel Lillo, Tucumán, Argentina; INHS, Illinois Natural History Survey, Champaign; INIA, Instituto Nacional de Investigaciones Agrícolas, Chapingo,

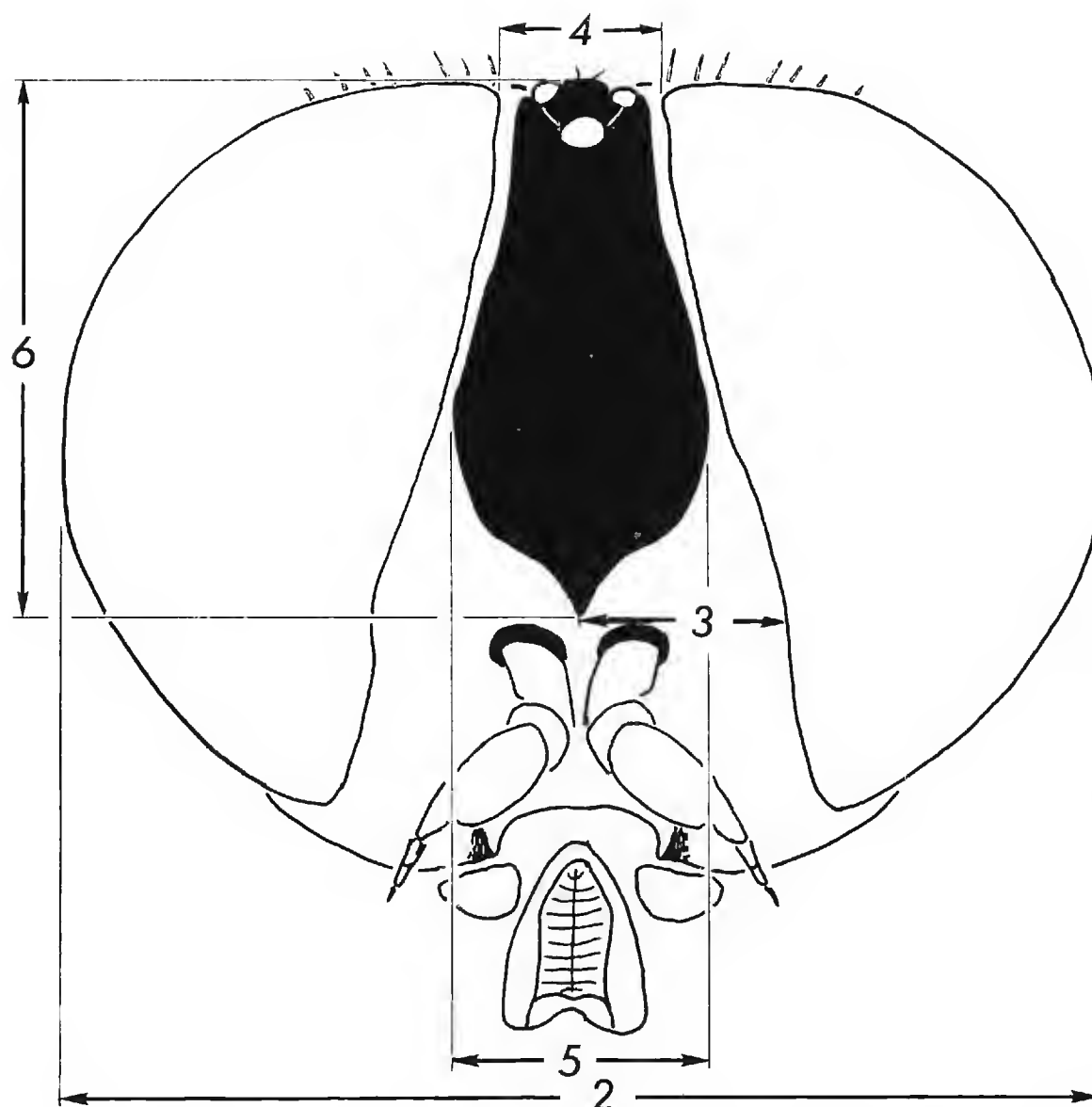
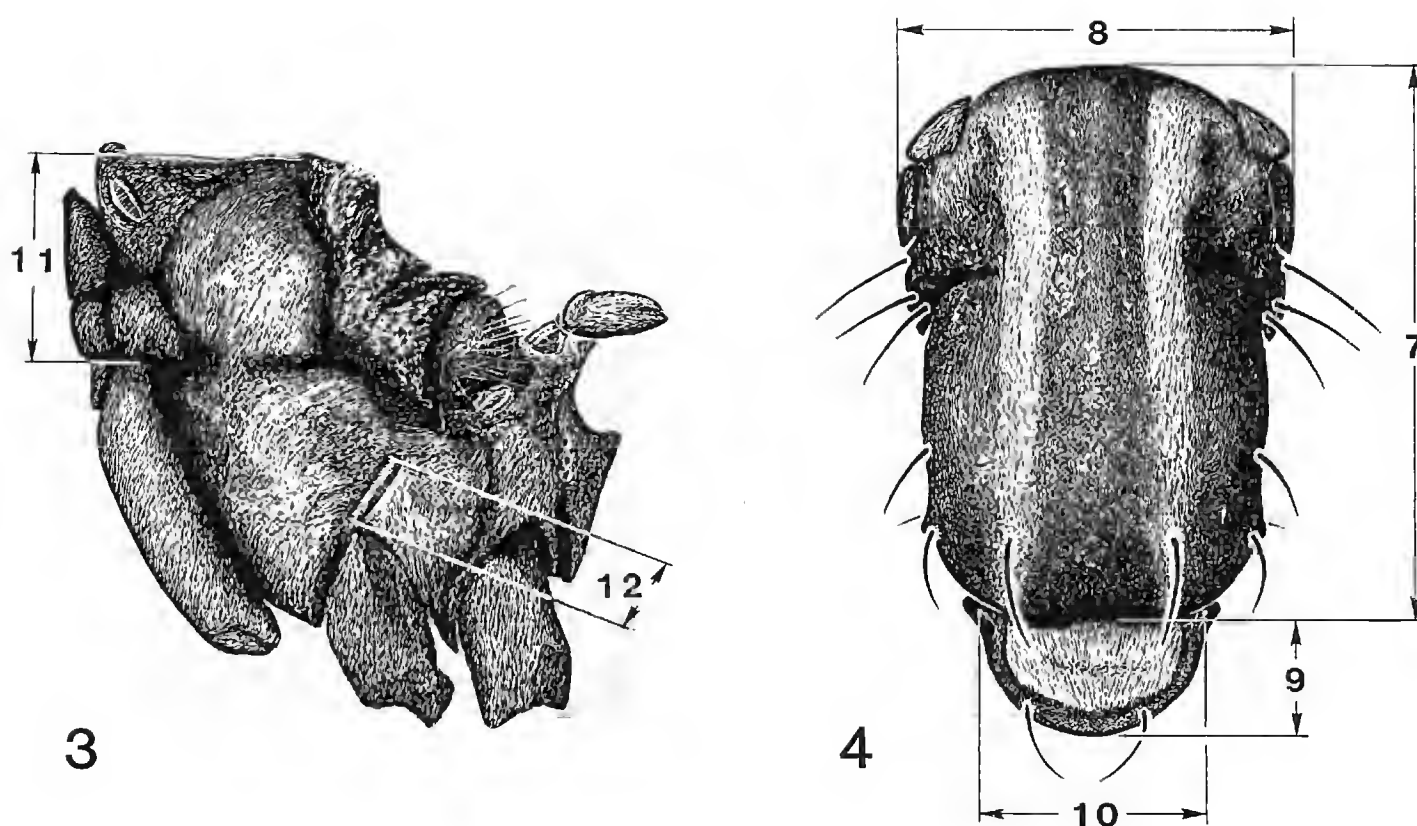


Fig. 2. *Pherocera rupina*, female (1725), head, frontal view. Arrows give linear measurements corresponding to continuous character states in text: 2 = head width; 3 = distance from center of frons to compound eye margin at dorsal margin of antennal socket; 4 = interocular distance at vertex; 5 = width of frontal callosity; 6 = height of frontal callosity.

Mexico; IOC, Instituto Oswaldo Cruz, Rio de Janeiro, Brazil; IRSN, Institut Royal des Sciences Naturelle de Belgique, Brussels; ISU, Iowa State University, Ames; ITM, Instituto Tecnológico y de Estudios Superiores, Monterrey, Mexico; KSU, Kansas State University, Manhattan; KUF, Kyushu University, Fukuoka, Japan; LACM, Natural History Museum of Los Angeles County, California; LBSC, California State University at Long Beach; MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; MEI, M. E. Irwin Collection; MHN, Museo de Historia Natural Javier Prado, Lima, Peru; MMB, Moravske Museum, Brno, Czechoslovakia; MNH, Musei Nationalis Hungarici, Budapest, Hungary; MNHN, Museum National d'Histoire Naturelle, Paris, France; MSU, Michigan State University, East Lansing; NCSU, North Carolina State University, Raleigh; NMB, Naturhistorisches Museum, Basel, Switzerland; NMP, Natal Museum, Pietermaritzburg, South Africa; NMSU, New Mexico State University, Las Cruces; NSDA, Nevada State Department of Agriculture, Reno; OSM, Ohio State Museum, Columbus; OSU, Oregon State University, Corvallis; PAS, Polish Academy of Sciences, Warsaw; RNHL, Rijkmuseum van Natuurlijke Historie, Leiden, The Netherlands; SDAP, State Department of Agriculture, Harrisburg, Pennsyl-



Figs. 3, 4. Thorax of *Pherocera rupina* female (1725). 3, Lateral view. 4, Dorsal view. Arrows give linear measurements corresponding to continuous character states in text: 7 = length of thorax exclusive of scutellum; 8 = width of thorax at wing bases; 9 = length of scutellum; 10 = width of scutellum; 11 = distance between ridge above prothoracic spiracle and basal margin of forecoxa; 12 = length of mesopleural suture separating katepisternum and katepimeron.

vania; SDCM, San Diego County Museum, California; SJSC, San Jose State University, California; SMN, Staatlichen Museum für Naturkunde, Stuttgart, West Germany; SWRS, Southwestern Research Station (AMNH), Portal, Arizona; TAM, Texas Agricultural and Mechanical University, College Station; UA, University

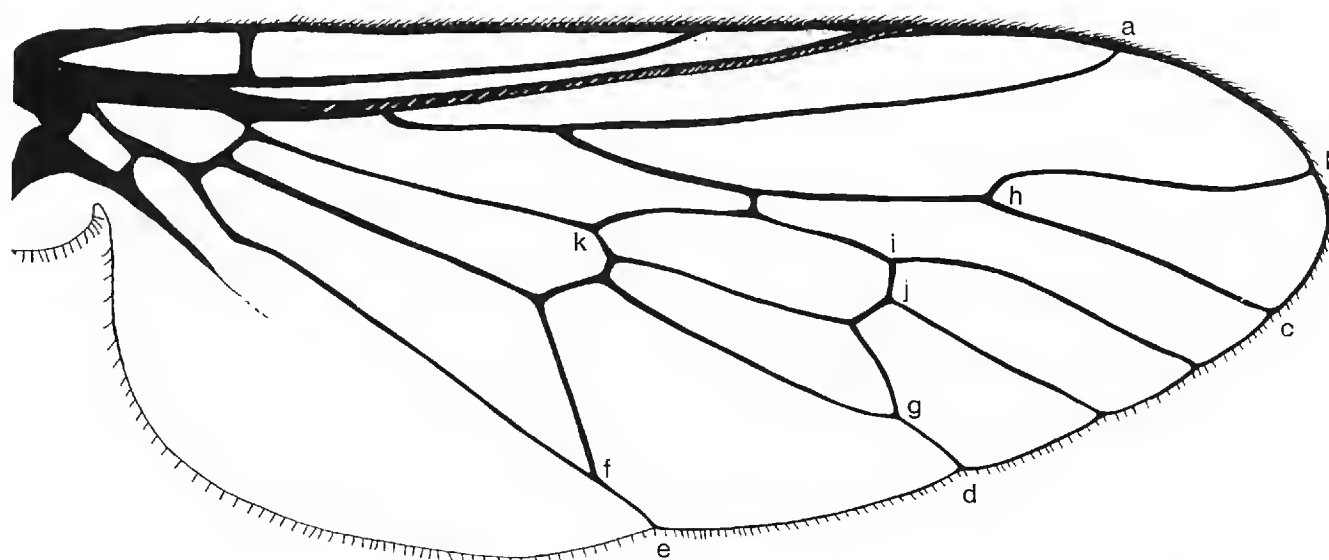


Fig. 5. Wing of *Pherocera rupina* male (3185). Letters give landmarks between which linear measurements correspond to continuous character states in text: g-d (character 13) = length of vein M_3+CuA_1 ; f-e (character 14) = length of $Cu_2+2nd\ A$; a-i (character 15) = distance from distal end of R_{2+3} to distal margin of 1st M_2 cell; h-b (character 16) = length of vein R_4 from fork of R_{4+5} ; h-c (character 17) = length of vein R_5 from fork of R_{4+5} ; b-c (character 18) = distance from distal end of vein R_4 to distal end of vein R_5 ; k-j (character 19) = longest length of 1st M_2 cell; h-i (character 20) = distance from fork R_{4+5} to closest point of 1st M_2 cell.

of Arizona, Tucson; UAC, University of Alberta, Canada; UCB, University of British Columbia, Vancouver, Canada; UCD, University of California, Davis; UCM, University of Colorado Museum, Boulder; UCR, University of California, Riverside; UCVM, Universidad Central de Venezuela, Maracay; UG, University of Georgia, Athens; UI, University of Idaho, Moscow; UK, University of Kansas, Lawrence; UM, University of Minnesota, Saint Paul; UMA, University of Michigan, Ann Arbor; UNLP, Museo de Ciencias Naturales, Universidad Nacional de La Plata, Argentina; USI, University of Southern Illinois, Carbondale; USNM, United States National Museum, Washington, D.C.; USSR, Zoological Institute USSR, Leningrad; USU, Utah State University, Logan; UTA, University of Texas, Austin; UTI, University of Tel Aviv, Israel; UU, University of Utah, Salt Lake City; UW, University of Wisconsin, Madison; UZM, Universitetets Zoologiske Museum, Copenhagen, Denmark; VNM, Naturhistorisches Museum, Vienna, Austria; WSU, Washington State University, Pullman; ZIB, Zoologisches Institut, Berlin, West Germany; ZSI, Zoological Survey of India Collection, Calcutta, India.

Characters used—continuous character states.—The following characters were measured for all female *boharti* group holotypes herein described (Table 1):

Overall length

- Ch. 1. Measurements were taken from the posterior tip of the abdomen to and including any protuberance on the frons, but not including the antennae.

Head, measured as illustrated in Fig. 2.

- Ch. 2. Head width.
- Ch. 3. Distance from center of frons to compound eye margin at dorsal margin of antennal socket.
- Ch. 4. Interocular distance at vertex.
- Ch. 5. Width of frontal callosity. The frontal callosity (= dark shiny area between compound eyes of most females in the genus *Pherocera*) is an extremely important species specific character. Males in the *boharti* group lack this callosity.
- Ch. 6. Height of frontal callosity. This character was sometimes difficult to measure on rubbed specimens because it was difficult to determine where the callosity ended and the ocellar tubercle began.

Thorax, measured as illustrated in Figs. 3 and 4.

- Ch. 7. Length of thorax exclusive of scutellum.
- Ch. 8. Width of thorax at wing bases.
- Ch. 9. Length of scutellum measured from posterior margin of scutellum, through its center, to posterior margin of mesonotum.
- Ch. 10. Width of scutellum, measured to include widest part of scutellum excluding basal flanges.
- Ch. 11. Distance between ridge above prothoracic spiracle and basal margin of forecoxa.
- Ch. 12. The length of the broad ventral section of the mesopleural suture separating the katepisternum and katepimeron.

Wing, measured as illustrated in Fig. 5. This illustration gives landmarks, as letters (a) through (k), and the following characters represent linear measurements between landmarks:

- Ch. 13. g-d Length of vein M_3+Cu_1 .
- Ch. 14. f-e Length of $Cu_2+2nd\ A$.
- Ch. 15. a-i Distance from distal end of R_{2+3} to distal margin of 1st M_2 cell.
- Ch. 16. h-b Length of R_4 from fork of R_{4+5} .
- Ch. 17. h-c Length of R_5 from fork of R_{4+5} .
- Ch. 18. b-c Distance from distal end of R_4 to distal end of R_5 .
- Ch. 19. k-j Longest length of 1st M_2 cell.
- Ch. 20. h-i Distance from fork R_{4+5} to closest point of 1st M_2 cell.

Characters used—discrete character states.—The characters listed below form a matrix (Table 2) with the included species in the *boharti* group. It is hoped that the matrix will prove useful in the separation and recognition of species, augmenting to some degree the dichotomous key.

- Ch. 21. Lower gena
 - a. entirely tomentose (Fig. 14).
 - b. with a definite bare stripe (Figs. 12, 13, 15-19). In one species no bare area exists on the lower gena (*P. tomentamala*, state 21a), while a definite bare area, generally confined to a narrow stripe between the frontobasal compound eye margin and the lower margins of the oral cavity, is evident on the remaining species of the *boharti* group (state 21b). Rubbed specimens sometimes have "bare" areas on the genae, but these are generally less well defined than the true non-tomentose stripe of state 21b.
- Ch. 22. Cuticular coloration of thorax
 - a. orange to red
 - b. dark brown to black
- Ch. 23. Cuticular coloration of abdomen
 - a. orange to red
 - b. light brown to tan
 - c. mostly dark brown to black
- Ch. 24. Thoracic vittae
 - a. distinct, dark
 - b. indistinct, powdered over, but discernible
 - c. indiscernible
- Ch. 25. Cuticular coloration of palp
 - a. light brown to tan
 - b. dark brown to black
- Ch. 26. Cuticular coloration of hindfemur
 - a. mostly dark brown to black
 - b. mostly reddish-orange to tan
- Ch. 27. Cuticular coloration of midfemur
 - a. mostly dark brown to black
 - b. mostly reddish-orange to tan
- Ch. 28. Cuticular coloration of midtibia
 - a. mostly dark brown to black
 - b. mostly reddish-orange to tan
- Ch. 29. Frontal callosity of female
 - a. reaching ocellar tubercle
 - b. not reaching ocellar tubercle

Table 1. Measurements in mm of holotype females of the *boharti* group (the *P. flavipes* specimen is not the holotype).

Characters	Species and specimen number							
	<i>bishop-ensis</i> 2804	<i>boharti</i> 1624	<i>boydi</i> 1537	<i>flavipes</i> 1330	<i>nigragena</i> 1578	<i>rufob-dominalis</i> 2626	<i>rupina</i> 1725	<i>tomen-tamala</i> 1670
1	5.26	4.76	4.31	4.82	5.60	4.65	4.87	5.04
2	1.36	1.20	1.19	1.23	1.48	1.30	1.40	1.29
3	0.31	0.24	0.25	0.31	0.36	0.28	0.27	0.28
4	0.18	0.18	0.18	0.21	0.21	0.18	0.20	0.21
5	0.31	0.38	0.28	0.42	0.42	0.27	0.32	0.31
6	0.27	0.60	0.62	0.60	0.64	0.38	0.70	0.57
7	1.36	1.29	1.26	1.26	1.50	1.27	1.43	1.33
8	1.37	1.06	1.06	1.20	1.27	1.20	1.37	1.26
9	0.28	0.27	0.25	0.25	0.36	0.28	0.31	0.28
10	0.52	0.56	0.48	0.50	0.59	0.29	0.59	0.57
11	0.48	0.41	0.41	0.49	0.56	0.46	0.53	0.50
12	0.15	0.14	0.17	0.17	0.18	0.17	0.18	0.18
13	0.20	0.14	0.15	0.20	0.14	0.13	0.13	0.13
14	0.24	0.17	0.17	0.13	0.18	0.22	0.17	0.18
15	0.91	0.81	0.83	0.78	0.88	0.78	0.91	0.88
16	0.92	0.88	0.88	0.81	0.95	0.84	0.85	0.97
17	0.87	0.88	0.87	0.80	0.87	0.80	0.80	0.91
18	0.45	0.42	0.34	0.36	0.42	0.34	0.42	0.43
19	0.84	0.84	0.71	0.84	0.97	0.81	0.85	0.84
20	0.34	0.28	0.28	0.34	0.32	0.32	0.39	0.35

- Ch. 30. Ventral gonocoxal spur of male terminalia
 - a. one-appendaged, molar-shaped or with minute teeth (Figs. 46–51)
 - b. one-appendaged, elongate molar-shaped, with rounded ventrolateral lobe (Fig. 45)
 - c. two-appendaged, one tapered, the other elongate, spine like (Fig. 44)
- Ch. 31. Adults mainly occur in
 - a. desert canyon bottom environments
 - b. montane environments
 - c. dry wash environments
 - d. inland stable sand dune environments
- Ch. 32. Principal landing substrate of adults is
 - a. rock
 - b. twig on ground
 - c. soil-leaf litter

Definition of special morphological terms.—Most terms used in this paper can be found in Torre-Bueno (1950), Lyneborg (1968, 1972), Irwin (1973, 1976, 1977), Irwin and Lyneborg (1981a, 1981b), and McAlpine *et al.* (1981); those that cannot or are used in a different connotation or otherwise need clarification follow:

Frontal callosity: The area of the female frons usually devoid of tomentum.
Genal stripe: The stripe, devoid of tomentum, on the lower gena connecting

Table 2. Discrete states of characters 21-32 explained in text for species of the *boharti* group.

Characters	Species							
	<i>bishop-ensis</i>	<i>boharti</i>	<i>boydi</i>	<i>flavipes</i>	<i>nigragena</i>	<i>rufoabdominalis</i>	<i>rupina</i>	<i>tomentamala</i>
21	b	b	b	b	b	b	b	a
22	b	a	b	b	b	b	b	b
23	a	b	c	c	c	a	c	c
24	b	c	b	a&b	a	b	b	b
25	a	a	b	b	b	a	a	b
26	b	b	b	b	a	b	a	b
27	b	b	b	b	a	b	a	b
28	b	b	b	b	b	b	a	b
29	b	a	a	a	a	b	a	a
30	a	b	c	a	a	a	a	a
31	c	b	a	a&b	a	a	a	d
32	a	c	a	a	a	a	a	b

the lower margin of the compound eye with the lower margin of the oral cavity.

Ventral gonocoxal spur: An extension of the gonocoxite (Fig. 10, vgs), possibly homologous with the ventral lobe of the gonocoxite of Lyneborg (1968) and Irwin and Lyneborg (1981a).

Pile: Long, thin hair without a noticeable socket.

Tomentum: Short, scalelike hair densely covering exoskeleton; sometimes referred to by other authors as pollen.

The *boharti* Group of *Pherocera*

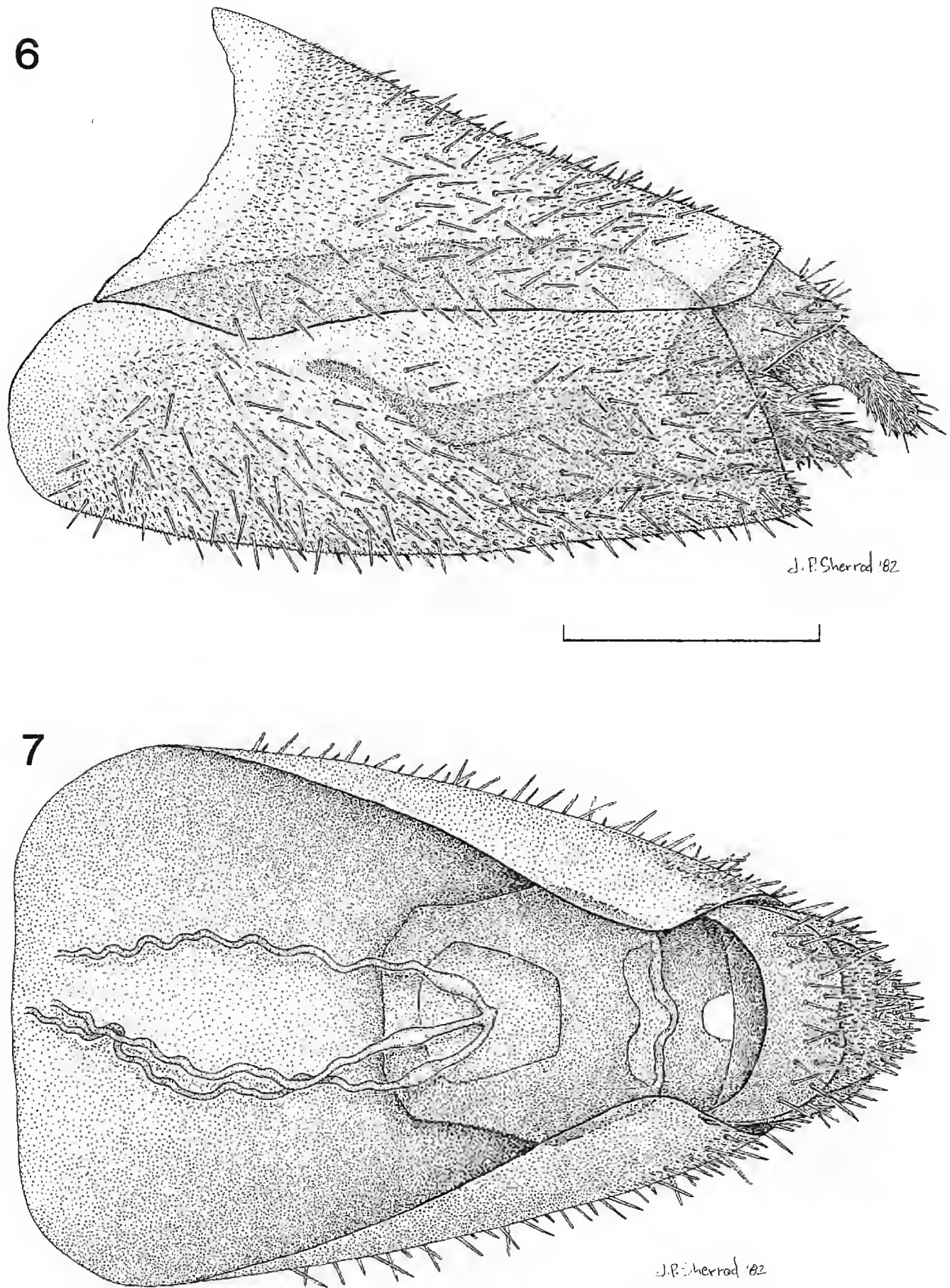
Diagnosis.—Body usually dark brown to black (*rufoabdominalis* and *bishopensis* with red abdomens, *boharti* with reddish-orange thorax, tan abdomen); tomentum usually silver to silver-gray, dense on face and thorax, sparse on abdomen.

Head: Tomentum dense, silver-gray on upper frons and vertex and silver on lower frons and gena; facial pile white; palp white pilose; female dichoptic, facets of uniform size; male holoptic, facets divided in most species, or facet size grading from smaller ventrad to larger dorsad (*boydi*, *tomentamala*); antennal flagellum pear-shaped to elongate pear-shaped (Figs. 20-27); maxillary palp with distinct terminal indentation, one-jointed (Figs. 28-35).

Thorax: Mesonotal vittae distinct (*nigrigena*, *flavipes*), indistinct but discernible (*bishopensis*, *boydi*, *flavipes*, *rufoabdominalis*, *rupina*, *tomentamala*), or indiscernible (*boharti*); vein M₃+CuA₁ reaching wing margin (Fig. 5, g-d). Halter knob white; proximal 3/4 to 5/6 of foretibia with dense, white pile.

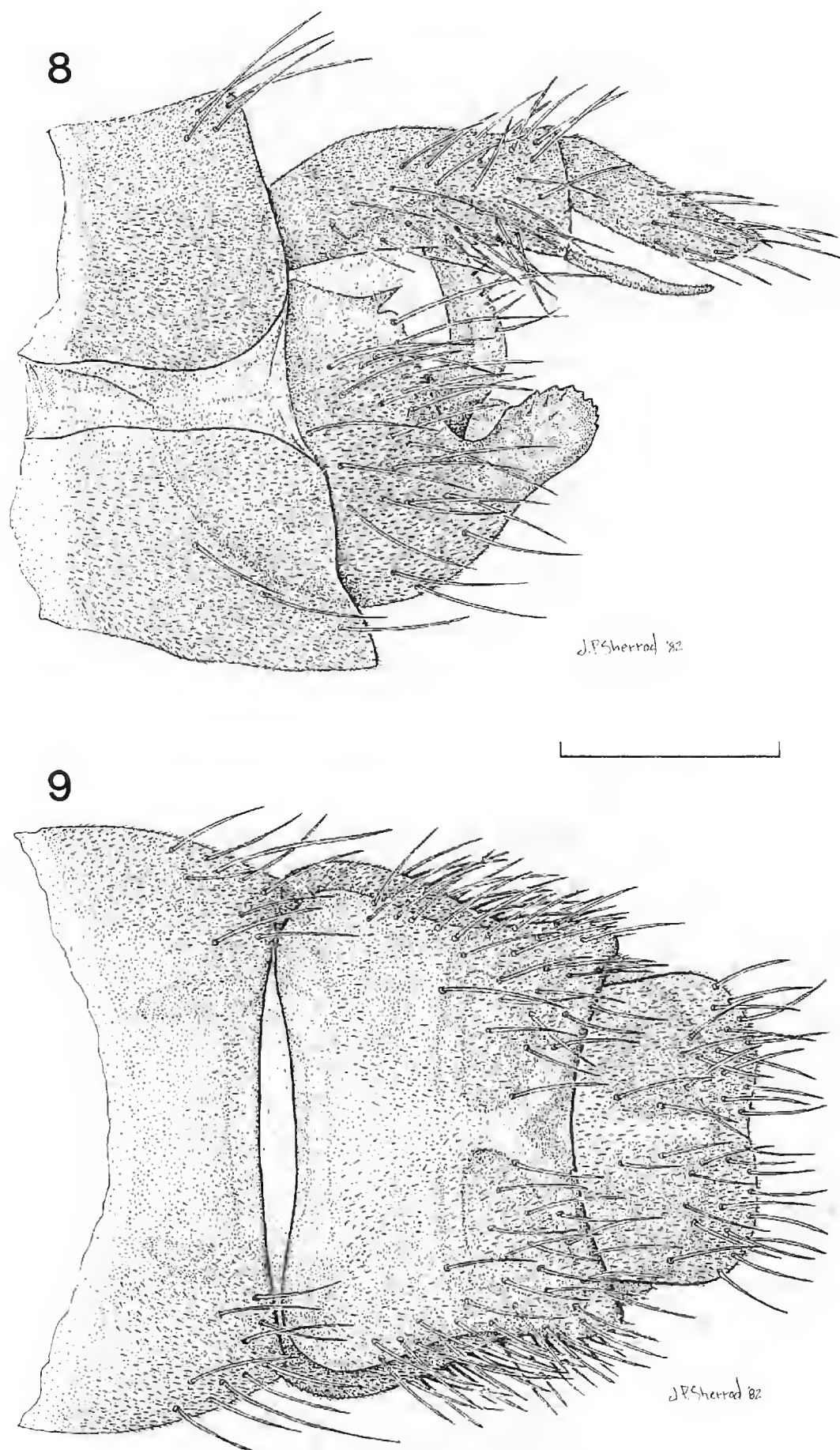
Abdomen: Male terminalia (Figs. 8, 9) with hypoproct fitted partially beneath epandrium, variously shaped (Figs. 36-43); ventral gonocoxal spurs (vgs), gonostyli (g) (Fig. 10) variously shaped (Figs. 44-51), and aedeagus (Fig. 11) complex (Figs. 52-59). Female terminalia (Figs. 6, 7) simple; furca with two membranous areas, through the anterior of which passes the coalesced spermathecal duct (Fig. 7).

Relationships.—The *boharti* group has a sister-group relationship with the *albihalteralis* group, for which *P. albihalteralis* was formally described (Cole, 1923a), but can be distinguished from it by the ventral gonocoxal spur being one-appen-



Figs. 6, 7. Female terminalia of *Pherocera rufoabdominalis* (2506). 6, Lateral view. 7, Dorsal view with tergite 8 removed. Scale = 0.2 mm.

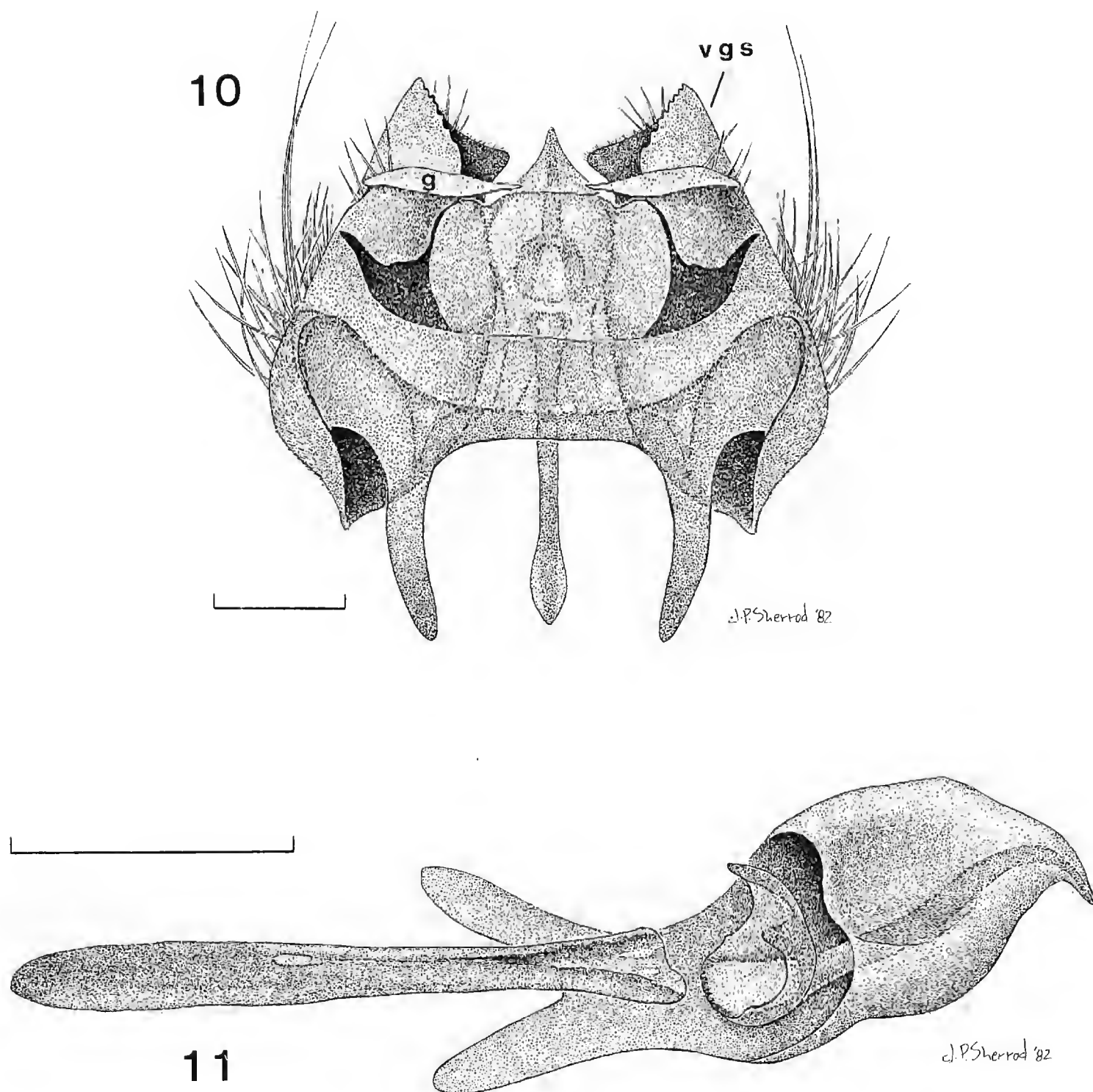
daged, one molar-shaped or rounded and with minute teeth (Figs. 46–51), one-appendaged, elongate molar-shaped with a lateroventral rounded lobe (Fig. 45), or two-appendaged, one molar-shaped, the other spinelike (Fig. 44), while members of the *albihalteralis* group have spurs two-appendaged, sharp, spinelike, equal or unequal in length or one-appendaged, sharp, elongate or fanglike and elongate.



Figs. 8, 9. Male terminalia of *Pherocera rufoabdominalis* (2432). 8, Lateral view. 9, Dorsal view. Scale = 0.2 mm.

The *boharti* group is also characterized by having a bare stripe on each lower gena between the frontobasal compound eye margins and the lower margins of the oral cavity (except *P. tomentamala*).

Within the *boharti* group the species may be further grouped on the basis of their ventral gonocoxal spurs and gonostyli. Two related species, *bishopensis* and



Figs. 10, 11. Male genitalia of *Pherocera rufoabdominalis* (2511). 10, Dorsal view with epandrium removed. 11, Aedeagus, dorsolateral view. Scale = 0.1 mm.

rufoabdominalis, are distinct in having hatchet-shaped gonostyli and cuspidlike ventral gonocoxal spurs. *P. boydi* is distinct in having spinelike and exaggeratedly lobed ventral gonocoxal spurs. *P. boharti* is characterized by an elongate, cuspid-shaped ventral gonocoxal spur and a gonostylus with an elongate lateral spine. *P. rupina*, *tomentamala*, *nigragenae*, and *flavipes* appear closely related, having elongate, sometimes double-tipped, gonostyli and single ventral gonocoxal spurs that are molar-shaped in appearance.

Included species.—*P. bishopensis* Irwin, sp. nov.; *P. boharti* Irwin, sp. nov.; *P. boydi* Irwin, sp. nov.; *P. flavipes* Cole, 1923a; *P. nigragenae* Irwin, sp. nov.; *P. rufoabdominalis* Irwin, sp. nov.; *P. rupina* Irwin, sp. nov.; and *P. tomentamala* Irwin, sp. nov.

KEY TO THE SPECIES OF THE BOHARTI GROUP

- 1. Palps dark brown to black 2
- Palps yellow to light brown 5
- 2. Hindfemur dark brown to black; ventral gonocoxal spur and gonostylus (♂) as in Fig. 49; frontal callosity (♀) as in Fig. 16 .. *nigragena* Irwin, sp. nov.
- Hindfemur mostly orange to tan 3
- 3. Lower gena without a bare stripe; ventral gonocoxal spur and gonostylus (♂) as in Fig. 46; frontal callosity (♀) as in Fig. 14 *tomentamala* Irwin, sp. nov.
- Lower gena with bare stripe 4
- 4. Ventral gonocoxal spur (♂) bilobed, one elongate, spinelike (Fig. 44); frontal callosity (♀) as in Fig. 12. Mesonotal vittae indistinct, powdered over *boydi* Irwin, sp. nov.
- Ventral gonocoxal spur (♂) molar-shaped (Fig. 48); frontal callosity (♀) as in Fig. 17. Mesonotal vittae usually distinct *flavipes* Cole
- 5. Abdomen red; thorax dark brown to black 6
- Abdomen tan or brown; thorax dark brown to tannish-orange 7
- 6. Frontal callosity (♀) with central tomentose zone (Fig. 19); ventral gonocoxal spur and gonostylus (♂) as in Fig. 51 *bishopensis* Irwin, sp. nov.
- Frontal callosity (♀) without tomentose island (Fig. 18); ventral gonocoxal spur and gonostylus (♂) as in Fig. 50 *rufoabdominalis* Irwin, sp. nov.
- 7. Thorax orangish-tan; frontal callosity (♀) as in Fig. 13; ventral gonocoxal spur and gonostylus (♂) as in Fig. 45 *boharti* Irwin, sp. nov.
- Thorax black or dark brown; frontal callosity (♀) as in Fig. 15; ventral gonocoxal spur and gonostylus (♂) as in Fig. 47 *rupina* Irwin, sp. nov.

Pherocera bishopensis Irwin, Sp. Nov.

(Figs. 19, 26, 34, 43, 51, 58)

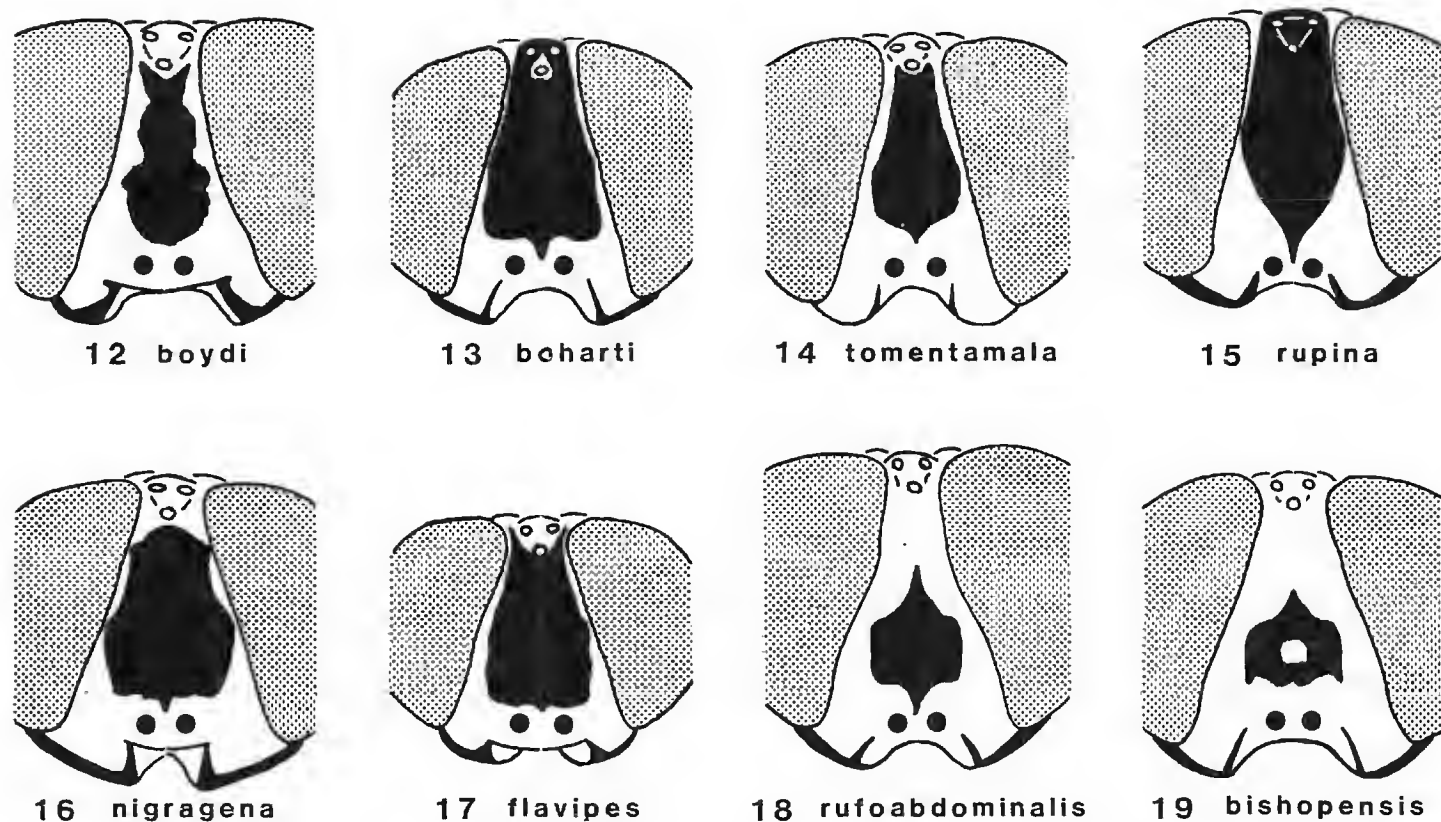
Derivation of name.—Bishop = type locality; *-ensis* (Latin) = of or from.

Diagnosis.—*P. bishopensis* can be distinguished from all other species of the *boharti* group by the following combination of characters: mesonotal vittae indistinct, abdominal coloration red, frontal callosity of female not reaching ocellar tubercle and having a tomentose area within the bounds of the frontal callosity (Fig. 19); male terminalia with hypoproct as in Fig. 43 and ventral gonocoxal spur and gonostylus as in Fig. 51.

Description, female holotype.—See Table 1 for holotype measurements, Table 2 for discrete character states.

Head: Dark brown. Face and frontal callosity as in Fig. 19. Tomentum silver-gray on vertex and upper frons, brownish above frontal callosity, silver on lower frons and gena. Pile lacking on ocellar tubercle; sparse, short, white dorsolaterad of antennal socket; sparse, longer on lower gena and palp. Ratio of antennal scape : pedicel : flagellum, 15:9:32; scape reddish-tan with two black setae ventrad, reddish-tan pile sparsely over entire segment; pedicel dark brown with short, white pile forming ring distally; flagellum (Fig. 26) dark brown, bare. Palp (Fig. 34) light brown, nearly translucent. Proboscis dark brown.

Thorax: Dark brown; mesonotal vittae indistinct but discernible; tomentum gray-brown, moderately dense on mesonotum, very dense on scutellum; meso-



Figs. 12-19. Heads of females of *Pherocera boharti* group, frontal views. 12, (2794); 13, (2800); 14, (1670); 15, (2808); 16, (2796); 17, (2831); 18, (2806); 19, (2804). Scale = 0.5 mm.

notal pile very short, light colored, sparse, present only posteriorly; pile short, sparse on scutellum; pleural region sparsely silver tomentose, even sparser on anepimeron and katatergite; coxae mostly red with proximal $\frac{1}{2}$ of hindcoxa and most of forecoxa dark brown; legs mostly red with forefemur, distal $\frac{1}{6}$ of foretibia, and all tarsi dark brown; pile on legs sparse, white.

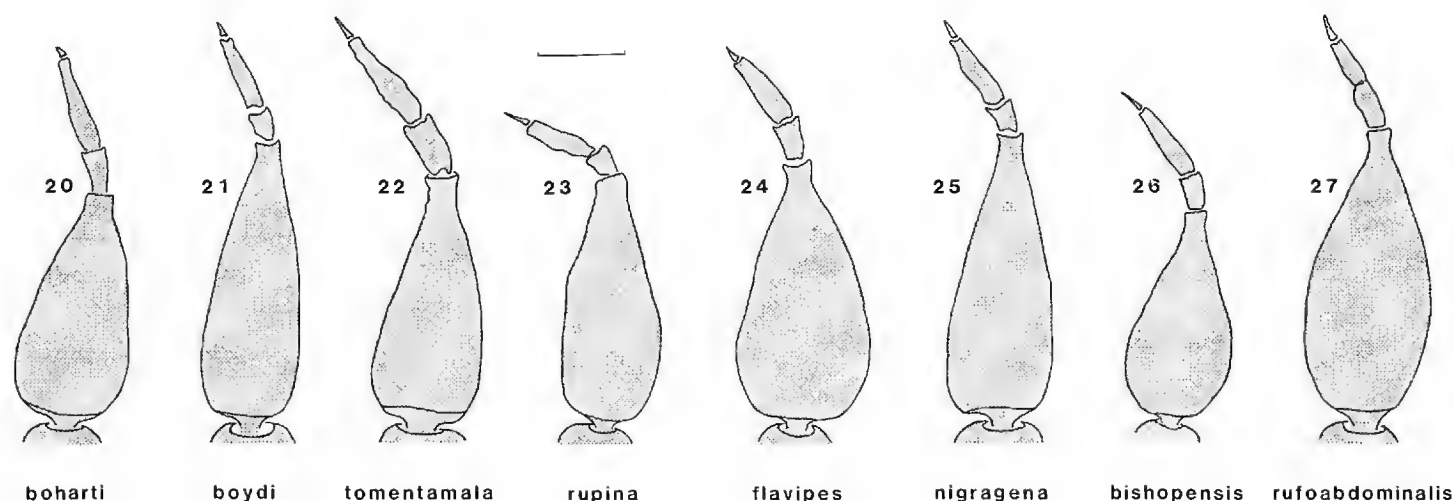
Abdomen: Cuticular coloration red; tomentum almost nonexistent, gray, sparse dorsally and centrally; pile short, evenly covering abdomen, white anteriorly and ventrally to black posteriorly; tergites I-IV fasciate.

Male.—Same as female holotype except as follows: pile short, black on ocellar tubercle; frons silver tomentose, pile on mesonotum white, short anteriorly to long posteriorly, even longer on scutellum; scape dark brown; coxae dark brown; distal sixth of middle and hindtibiae dark brown; distal third of foretibia dark brown; abdomen with a single mid-dorsal dark brown blotch on each of tergites I-IV; tergites I-III, faintly IV, fasciate; aedeagus as in Fig. 58; hypoproct as in Fig. 43; ventral gonocoxal spur and gonostylus as in Fig. 51.

Variation.—Overall length 3.6 mm to 5.1 mm ♂; 4.1 mm to 6.3 mm ♀; tergites I-II to I-IV fasciate; one specimen has a more intensely yellow palp and more intensely orange abdomen than other examined specimens; some have dark blotches on dorsal midline of tergites.

Distribution and ecological placement.—*P. bishopensis* appears to be restricted to dry washes and desert canyon bottoms where *Populus* spp. abound in the Owens Valley (Inyo and Mono Counties) and the Mojave Desert (Los Angeles and Kern Counties), California.

Specimens examined.—Holotype: ♀, Irwin specimen number 2804, CAS type no. 10454; 4.8 kilometers south of Bishop (label reads Bishop), Inyo Co., California; EIS; July 20, 1960; under *Populus trichocarpa* Torrey & Gray. Paratopo-



Figs. 20-27. Antennal flagella of males of *Pherocera boharti* group, lateral view. 20, (1633); 21, (1523); 22, (1669); 23, (1807); 24, (1192); 25, (1594); 26, (2714); 27, (2453). Scale = 0.1 mm.

types: 85 ♂; 64 ♀. Other specimens: 1 ♂; 2 ♀. The following specimens were examined:

CALIFORNIA: Inyo Co.: Bishop, 4.8 km S, 1265 m, 60/07/20, EIS, 85 ♂, 65 ♀; **Kern Co.:** Walker Pass, 1585 m, 58/08/19, RHP EMP, 1 ♂; **Los Angeles Co.:** Lancaster, 12.9 km E, 56/09/06, EIS, 1 ♀; **Mono Co.:** Benton Station, 50/07/20, HAH, 1 ♀.

Comments.—Morphological separation of some males of *P. bishopensis* and *P. rufoabdominalis* is difficult. Female frontal callosity, ecological associations, and distribution patterns all help separate this species from *P. rufoabdominalis*, its sister species.

***Pherocera boharti* Irwin, SP. NOV.**

(Figs. 13, 20, 28, 37, 45, 52)

Derivation of name.—Named in honor of Dr. Richard M. Bohart.

Diagnosis.—This species can be distinguished from all others in the *boharti* group by the following combination of characters: frontal callosity (♀) as in Fig. 13; thorax orange; mesonotal vittae indistinguishable; male terminalia with hypoproct as in Fig. 37 and ventral gonocoxal spur and gonostylus as in Fig. 45.

Description, female holotype.—See Table 1 for holotype measurements, Table 2 for discrete character states.

Head: Face and frons similar to Fig. 13, slightly less tomentum on frons. Light brown from midfrons down, dark brown above. Tomentum dense, silver throughout; pile lacking on ocellar tubercle; white, moderately long dorsolaterad of antennal socket; sparse, moderately long, white posterior of genal stripe. Ratio of antennal scape : pedicel : flagellum, 17:7:34; scape with one short, black seta ventrad, white pilose; pedicel with distal ring of white and black pile; flagellum (Fig. 20) bare; antennae dark brown; palp (Fig. 28) light brown; proboscis dark brown.

Thorax: Orange; mesonotal vittae indiscernible; tomentum extremely sparse, gray, not obliterating ground color; pile black, sparse over mesonotum and scutellum; pleural region sparsely silver tomentose on anepisternum, katepisternum, katepimeron and metanepisternum; lacking on anepimeron and katatergite; anepisternum sparsely short, white tomentose; katatergite with sparse, tan and elongate tomentum; coxae orangish-tan, silver tomentose, white pilose; legs orange

with proximal $\frac{1}{2}$ of hindtibia light brown and distal $\frac{1}{2}$ dark brown, forecoxa and femur brown, distal $\frac{1}{2}$ of midtibia brown, proximal $\frac{2}{3}$ of foretibia white, distal $\frac{1}{3}$ dark brown; all tarsi dark brown; wing veins brown.

Abdomen: Tan, darker brown dorsally; tomentum absent; pile short, black, appressed mesally; tergites I–II, faintly IV, fasciate.

Male.—Same as female holotype except as follows: antennal scape with two black setae ventrad; pile short, black on ocellar tubercle; tomentum white on anterolateral margins of mesonotum; tomentum golden on scutellum; hindcoxa and trochanter dark brown; midtrochanter dark brown; abdomen dark brown; abdominal pile long, white, erect laterally, shorter, black, appressed ventrally and dorsally; aedeagus as in Fig. 52; hypoproct as in Fig. 37; ventral gonocoxal spur and gonostylus as in Fig. 45.

Variation.—Overall length 3.6 mm to 5.0 mm ♂; 4.2 mm to 5.2 mm ♀; one female with black pile on ocellar tubercle; abdomen of female sometimes darker.

Distribution.—*P. boharti* has been collected from the transverse mountain range including the San Gabriel Mountains in Los Angeles County and the San Bernardino Mountains in San Bernardino County, California, in association with oak-woodland leaf litter. A small series was collected by RMB near Warner Springs, San Diego County, California. It was subsequently learned (R. M. Bohart, pers. comm.) that the collector had just recently come from the San Gabriel Mountains and had collected the specimens from inside the car. It is possible that these specimens were transported by car from the Tanbark Flat area to Warner Springs.

Specimens examined.—Holotype: ♀, Irwin specimen number 1624, CAS type no. 10455; Wildwood Canyon, 8 km east of Calimesa, San Bernardino Co., California, MEI; July 12, 1965; on wet sand near watering trough. Paratopotypes: 1 ♂; 23 ♀. Other paratypes: 4 ♂; 5 ♀. Other specimens: 6 ♀. The following specimens were examined:

CALIFORNIA: Los Angeles Co.: Big Dalton Canyon, 52/07/23, ATM, 1 ♂, 1 ♀; Glendale, 54/08/25, EIS, 1 ♂; 56/07/29, 1 ♀; San Francisquito Canyon, 56/07/15, LAS, 2 ♀; Tanbark Flat, 56/07/14, RMB, 1 ♂, 1 ♀. **San Bernardino Co.:** Calimesa, 8 km E at Wildwood Canyon, 57/07/09, HRM, 1 ♀; 57/07/13, JCH, 1 ♂; HRM, 2 ♀; 58/07/07, HRM, 2 ♀; 65/07/10, MEI, 2 ♀; 65/07/12, MEI, 13 ♀; 68/07/24, MEI, 4 ♀; Camp Baldy, 4.8 km W, 65/09/09, MEI, 1 ♂; Mountain Home, 44/08/24, ALM, 2 ♀. **San Diego Co.:** Warner Springs, 14.5 km S (*Sic!* see text), 56/07/08, RMB, 4 ♀.

***Pherocera boydi* Irwin, Sp. Nov.**

(Figs. 12, 21, 29, 36, 44, 53)

Derivation of name.—Named in honor of Mr. Philip L. Boyd who donated land that now forms the Deep Canyon Desert Research Center of the University of California, Riverside campus.

Diagnosis.—*P. boydi* can be distinguished from all other members of the *boharti* group by the following combination of characters: frontal callosity (♀) as in Fig. 12; mesonotum with indistinct vittae, heavily powdered over with silver to silver-gray tomentum; male terminalia with large hypoproct (Fig. 36) and unique-shaped ventral gonocoxal spur (Fig. 44).

Description, female holotype.—See Table 1 for holotype measurements, Table 2 for discrete character states. Body medium brown.

Head: Face similar to Fig. 12, frontal callosity fuller, rounder, extending through ocellar tubercle; tomentum gray near vertex, silver-gray on upper frons, silver on lower frons and gena; pile absent on ocellar tubercle, short, white dorsolaterad of antennal socket, absent on gena except short, white posterior to genal stripe; ratio of antennal scape : pedicel : flagellum, 15:7:35; scape with two long black setae ventrad, light brown pile overall; pedicel with distal ring of light tan pile; flagellum similar to Fig. 21, bare; antenna dark brown, brown tomentose; palp (Fig. 29) and proboscis dark brown.

Thorax: Mesonotal vittae indistinct but discernible, densely powdered over with silver-gray tomentum; tomentum covering scutellum; pile very short, sparse over mesonotum and scutellum; pleural region densely silver-gray tomentose on anepisternum, katepisternum, katepimeron, and metanepisternum, lacking on anepimeron and katatergite; anepisternum and katatergite with sparse, long, white pile; coxae reddish brown, silver-gray tomentose, white pilose; middle and hind-legs mostly orange or tannish-orange; foreleg black except proximal $\frac{2}{3}$ of tibia whitish.

Abdomen: Tomentum lacking; pile short, white (some black), more or less erect, covering entire abdomen; tergites I-IV fasciate.

Male.—Same as female holotype except as follows: light tan pile on ocellar tubercle; pile posterior to genal stripe longer and whiter; mesonotum more densely silver tomentose, short, white pilose; white pile on scutellum longer; white pile on abdomen much longer on tergites; tergites I-II, III faintly fasciate; aedeagus as in Fig. 53; hypoproct as in Fig. 36; ventral gonocoxal spur and gonostylus as in Fig. 44.

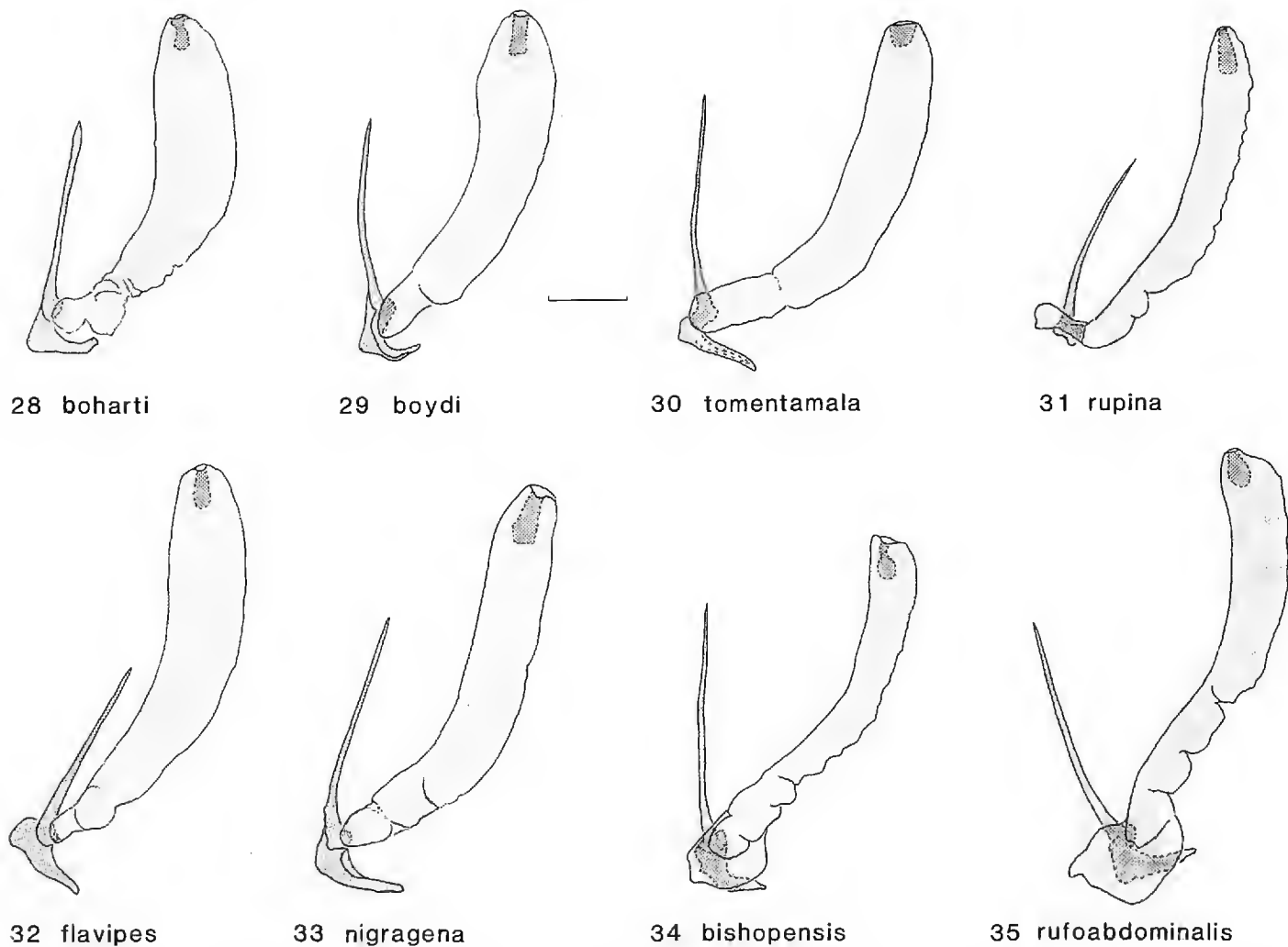
Variation.—Overall length 3.4 mm to 4.5 mm ♂; 4.0 mm to 5.4 mm ♀; female frontal callosity variable, more bulbous on lower frons, narrowing on upper frons; coxae and trochanter of male often black.

Distribution and ecological placement.—*P. boydi* seems restricted to desert canyon bottom environments, often in association with rock substrates under desert willow, *Chilopsis linearis* (Cavanilles). It has been collected from the San Jacinto, Santa Rosa, and Little San Bernardino Mountains, Riverside County; from the Daggett Hills, San Bernardino County; from the eastern foothills of the White Mountains, Inyo County, California; from Gila County, Arizona; from Hidalgo County, New Mexico; and from the eastern slope of the Sierra Juarez, Baja California Norte, Mexico.

Specimens examined.—Holotype: ♀, Irwin specimen number 1537, CAS type no. 10456; P. L. Boyd Deep Canyon Desert Research Center, 6.4 km south of Palm Desert, Riverside Co., California; EIS; July 1, 1964; under *Chilopsis* in lower part of canyon. Paratopotypes: 18 ♂; 17 ♀. Other specimens: 8 ♂; 8 ♀. The following specimens were examined:

MEXICO: Baja California Norte: Guadalupe Canyon, 365 m, 67/07/11, MEI, 1 ♂.

USA-ARIZONA: Gila Co.: San Carlos, 18/05/12, JCB, 1 ♀. **Maricopa Co.:** Canyon Lake, 58/05/30, JCH, 1 ♂. **CALIFORNIA: Inyo Co.:** Antelope Springs, 60/06/19, HKC, 1 ♂, 6 ♀. Westgard Pass, 6.4 km W, 61/06/19, JAP, 1 ♂. **Riverside Co.:** Massacre Canyon, 64/07/29, MEI, 1 ♂; P. L. Boyd Deep Canyon Desert Research Center, 6.4 km S of Palm Desert, 320 m, 63/05/15, EIS, 1 ♂; 63/06/21, EIS, 2 ♂, 1 ♀; 64/05/19, MEI, 1 ♀; 64/06/24, EIS, 2 ♂, 2 ♀; 64/07/01, GRB, 1 ♂;



Figs. 28–35. Palps of males of *Pherocera boharti* group, lateral view. 28, (1633); 29, (1523); 30, (1669); 31, (1807); 32, (1409); 33, (1594); 34, (2714); 35, (2453). Scale = 0.1 mm.

EIS, 1 ♀; 65/06/08, MEI, 1 ♂; 67/05/19, MEI, 1 ♂; 69/05/18, MEI, 1 ♀; 69/05/21, MEI, 1 ♀; 69/05/24, MEI SIF, 4 ♂, 4 ♀; 69/06/15, SIF RMW, 3 ♀; 69/06/23, SIF RMW, 1 ♂; 69/06/28, SIF RMW, 1 ♂; 69/06/29, SIF RMW, 1 ♀; 69/07/03, SIF RMW, 2 ♀; 69/07/05, SIF RMW, 1 ♂; 65/06/08, MEI, 1 ♂; **373 m**, 65/06/08, MEI, 1 ♀; **381 m**, 69/06/29, SIF, 1 ♂; Whitewater Canyon, 63/07/26, EIS, 2 ♂. **San Bernardino Co.:** Daggett, 55/05/22, WRM, 1 ♀. **NEW MEXICO: Hidalgo Co.:** Rodeo, 8 km N, **1380 m**, 65/06/01, MEI, 1 ♂.

***Pherocera flavipes* Cole**
(Figs. 17, 24, 32, 41, 48, 56)

Pherocera flavipes Cole, 1923a, Proc. U.S. Natl. Mus. 62(4):22.

Derivation of name.—*flavus* (Latin) = yellow; *pes* (Latin) = foot.

Diagnosis.—*P. flavipes* can be distinguished from all other species in the *boharti* group by the following combination of characters: female frontal callosity occupying nearly all of frons (Fig. 17); cuticular coloration usually black; mesonotal vittae usually distinct; palp dark brown; middle and hindfemora and tibiae usually orange; antennal flagellum as in Fig. 24; palp as in Fig. 32; male terminalia with aedeagus as in Fig. 56, ventral gonocoxal spur and gonostylus as in Fig. 48, and hypoproct as in Fig. 41.

Description, female.—(Comments on holotype): This species was adequately described by Cole (1923a, pp. 22–23) except as follows: length 5.3 mm; both antennal styli are entire; coxae partly orange, partly brown.

Male.—Similar to female holotype (see Cole, 1923a) except as follows: pile short, black on ocellar tubercle, white dorsolaterad of antennal socket, longer, white posterior to genal stripe; ratio of antennal scape : pedicel : flagellum, 18:3:39; scape with four black setae ventrad and white pile; pedicel with distal ring of white pile; flagellum bare; palp and proboscis dark brown; mesonotal vittae distinct, black, silver tomentose; mesonotal pile long, white; tarsi dark brown; abdomen black, white pilose, not tomentose; aedeagus as in Fig. 56; hypoproct as in Fig. 41; ventral gonocoxal spur and gonostylus as in Fig. 48.

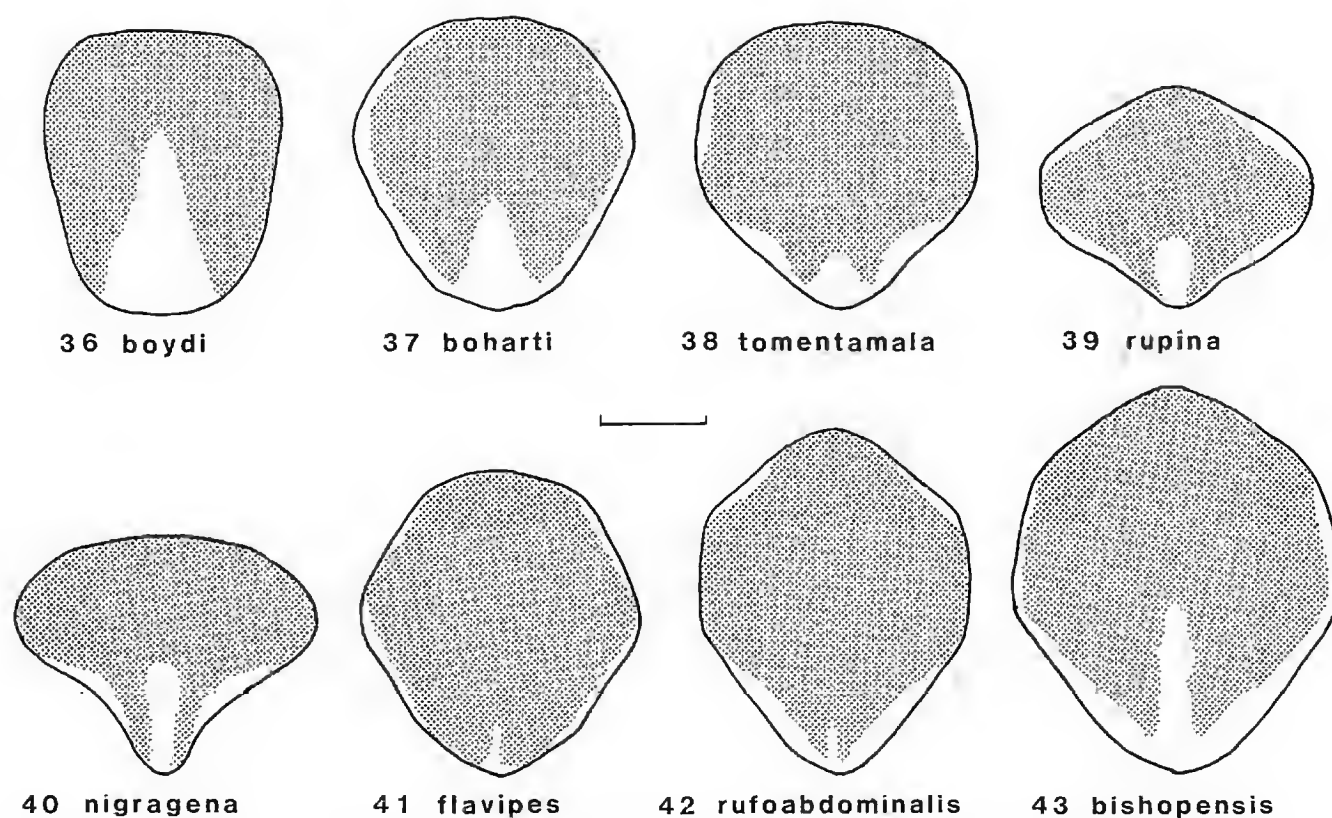
Variation.—Overall length 3.7 mm to 5.3 mm ♂; 4.1 mm to 5.9 mm ♀; the Wildwood Canyon, San Bernardino County, California population has the mesonotal vittae discernible but not distinct. The shape of the antennal flagellum varies from pear-shaped to elongate pear-shaped. *P. flavipes* is a variable species with rather indistinct and usually inseparable populations.

Distribution and ecological placement.—This species inhabits montane and desert canyon bottom environments where adults are often found on rock substrates. It has been collected from Arizona, California, Idaho, Nevada, New Mexico, and Utah in the United States; Baja California Norte and Baja California Sur in Mexico. *P. flavipes* has the widest distribution of all species of *Pherocera*.

Specimens examined.—Holotype: ♀, USNM: Higley (not Highley as reported by Cole, 1923a), Superstition Mountain, Pinal Co., Arizona; EGH; June 13, 1917. Other specimens: 132 ♂; 227 ♀. The following specimens were examined:

MEXICO: Baja California Norte: La Rumorosa, 14.5 km S, 1370 m, 67/07/08, MEI, 1 ♀. **Baja California Sur:** Isla Cerralvo, Gordas Point, 53/03/20, PHA, 1 ♀. Guadalupe, 100 km NW of La Paz, 107 m, 68/04/20, MEI, 6 ♂, 1 ♀. Loreto, 14.5 km S, 18 m, 68/04/17, MEI, 1 ♀. San Ignacio, 4.8 km E, 170 m, 68/04/14, MEI, 4 ♂, 2 ♀. Santa Rosalia, 40 km S, 61 m, 68/04/15, MEI, 1 ♂, 1 ♀.

USA-ARIZONA: Pima Co.: Alamo Canyon, Oregon Pipe National Monument, 47/04/16, ALM, 6 ♀. **CALIFORNIA: Inyo Co.:** Antelope Springs, 61/06/14, CAT, 1 ♂; 61/07/01, JAP, 1 ♂; 66/07/09, HKC, 1 ♀; Batchelder Spring, 67/07/21, MEI, 1 ♂, 7 ♀; Mountain Springs Canyon, Argus Mountains, 59/06/27, JCD, 4 ♂, 6 ♀; WCF, 1 ♂. **Lassen Co.:** Hallelujah Junction, 49/07/04, JWM, 1 ♀; 54/07/12, RMB, 1 ♀. **Los Angeles Co.:** Crystal Lake, 56/06/28, RCB, 1 ♀. **Napa Co.:** Monticello Dam, 62/09/15, MEI, 1 ♂. **Riverside Co.:** Massacre Canyon, 64/07/29, MEI, 1 ♀. Millard Canyon, 63/06/20, EIS, 1 ♀. P. L. Boyd Deep Canyon Desert Research Center, 6.4 km S of Palm Desert, 63/04/13, WAS, 1 ♂; 64/05/19, MEI, 2 ♂; 69/06/07, SIF, 1 ♂; 69/06/13, SIF, 1 ♂; 320 m, 64/05/19, MEI, 1 ♂; 64/05/31, MEI, 1 ♀; 65/05/24, MEI SIF, 2 ♂, 10 ♀; 65/06/08, MEI, 1 ♂; 69/05/16, MEI, 3 ♂; 69/05/17, JRQ, 1 ♂; 69/05/18, MEI, 13 ♂, 4 ♀; 69/06/10, SIF, 1 ♀; 69/06/15, SIF RMW, 1 ♂; 343 m, 64/05/19, MEI, 6 ♂, 2 ♀; 64/05/31, MEI, 1 ♀; 65/04/28, MEI, 1 ♂; 67/05/02, MEI, 5 ♀; 350 m, 65/06/08, MEI, 1 ♂; 366 m, 67/05/19, MEI, 1 ♂, 4 ♀; 373 m, 65/04/28, EIS, 1 ♂; 65/06/08, MEI, 1 ♂; 67/05/02, MEI, 1 ♀; 381 m, 63/05/03, EIS, 3 ♂; 63/05/17, EIS, 1 ♂; 63/06/21, EIS, 2 ♂; 65/06/08, MEI, 1 ♂; 67/05/19, MEI, 1 ♀; 400 m, 63/05/03, EIS, 6 ♀; 63/05/30, EIS, 1 ♀; 63/06/21, EIS, 2 ♀; 64/05/19, MEI, 5 ♂, 1 ♀; 64/05/31, MEI, 4 ♂, 1 ♀; 65/04/28, EIS, 1 ♂; MEI, 3 ♂, 3 ♀; 67/05/02, MEI, 1 ♂; 420 m, 65/04/28, EIS, 1 ♂; 67/05/19, MEI, 1 ♂; 1036 m, 65/06/11, MEI, 3 ♂, 8 ♀; EIS, 1 ♀; Palm Springs, Andreas Canyon, 55/05/03, WRM, 1 ♀; Pinon Flat, 48/05/26, AFH, 1 ♂; Thousand Palms Canyon, Willis Oasis, 55/04/12, WRM, 1 ♂; Whitewater Canyon, 63/06/07, EIS, 1 ♀; Winchester, 67/06/20, WI, 1 ♀; 67/06/23, WI, 2 ♀; 68/06/20, WI, 1 ♂, 1 ♀. **San Bernardino**



Figs. 36–43. Hypoprocts of male genitalia of *Pherocera boharti* group, dorsal view. 36, (1519); 37, (1635); 38, (1669); 39, (1787); 40, (1594); 41, (1192); 42, (3209); 43, (2639). Scale = 0.1 mm.

Co.: Calimesa, 8 km E at Wildwood Canyon, 57/07/09, HRM, 2 ♀; 57/07/13, JCH, 4 ♂, 1 ♀; HRM, 2 ♀; 65/07/10, MEI, 4 ♂, 59 ♀; RES, 10 ♀; 65/07/12, MEI, 17 ♂; 65/09/12, MEI, 1 ♂; 67/06/04, MEI PAR, 1 ♀; 68/07/24, MEI, 4 ♀; Camp Baldy, 4.8 km W, 65/09/09, MEI, 1 ♂; Daggett, 55/05/22, WRM, 4 ♂, 6 ♀; Helendale, 55/05/21, WRM, 1 ♀; **San Diego Co.:** Borrego Springs, 45/05/03, ALM, 1 ♀; 55/04/27, PDH, 1 ♀; 57/04/18, EIS, 2 ♂, 3 ♀; 57/04/19, JCH, 2 ♂, 1 ♀; RMB, 5 ♀; 60/04/21, JFL, 1 ♀; Culp Canyon, Anza-Borrego State Park, 58/06/12, EIS, 3 ♂, 8 ♀; JCH, 10 ♀; HRM, 5 ♀. **Ventura Co.:** Dry Canyon, 14.5 km E, 57/07/26, RAS, 1 ♀. **IDAHO: Twin Falls Co.:** Buhl, 32/07/08, DEF, 1 ♂. **NEVADA: Clark Co.:** Charleston Mountains at Willow Creek, 54/07/01, EIS, 2 ♂, 2 ♀; JWM, 1 ♂, 1 ♀. **NEW MEXICO: Hidalgo Co.:** Rodeo, 24 km N, 1380 m, 65/06/01, MEI, 1 ♂, 1 ♀; Rodeo, 8 km N, 1380 m, 65/06/01, MEI, 1 ♀. **UTAH: Grand Co.:** Arch Canyon, 35/06/23, CTB, 1 ♀; Browns Park, W of, 46/06/23, MTJ, 1 ♂; Castle Valley, 63/06/09, WJH, 1 ♂.

***Pherocera nigragena* Irwin, Sp. Nov.**

(Figs. 16, 25, 33, 40, 49, 57)

Derivation of name.—*nigra* (Latin) = black; *gena* (Latin) = cheek.

Diagnosis.—*P. nigragena* can be distinguished from all other species of the *boharti* group by the following combination of characters: female frontal callosity as in Fig. 16; mesonotum with vivid and distinct vittae; cuticular coloration of both mid and hindfemora mostly black or dark brown; midtibia mostly orange; cuticular coloration of palp dark brown; male terminalia with hypoproct as in Fig. 40 and ventral gonocoxal spur and gonostylus as in Fig. 49.

Description, female holotype.—See Table 1 for holotype measurements, Table 2 for discrete character states. Body black, silver tomentose.

Head: Face and frons similar to Fig. 16; frontal callosity narrow, tapering gradually from base to anterior ocellus. Pile absent on ocellar tubercle; sparse, white dorsolaterad of antennal socket; short, white posterior to genal stripe; white, longer, on palp. Ratio of antennal scape : pedicel : flagellum, 20:9:38; scape with three large, black setae lateroventrad, white pilose; pedicel with distal ring of short black pile; flagellum similar to Fig. 25; bare, antenna black; palp (Fig. 33) and proboscis dark brown.

Thorax: Mesonotal vittae distinct; mesonotal pile short, black; pleural region tomentose except for katatergite and anepimeron; anepisternum and katatergite densely long, white pilose; coxae tomentose, white pilose; legs black with distal $\frac{1}{4}$ of femora and proximal $\frac{1}{3}$ of tibiae of mid and hindlegs orange; distal $\frac{1}{10}$ of femur and proximal $\frac{1}{10}$ of tibia of foreleg orange; remainder of foretibia white and densely white pilose; legs predominantly black pilose.

Abdomen: Tomentum absent; tergite 1 with long, white pile; rest of abdomen short, black pilose; tergites I-III fasciate.

Male.—Same as female holotype except as follows: abdominal pile long, white laterad; shorter, dark, dorsad and ventrad. Aedeagus as in Fig. 57; hypoproct as in Fig. 40; ventral gonocoxal spur and gonostylus as in Fig. 49.

Variation.—Overall length 4.2 mm to 5.5 mm ♂; 4.2 mm to 6.2 mm ♀; legs of some specimens with slightly more orange to almost no orange.

Distribution and ecological placement.—*P. nigragena* was collected in dry montane environments characterized by cold winters and cool summers; most of the specimens collected by the author were associated with rock substrates under willow trees (*Salix* spp.). It has been collected in the more northern areas of California (Inyo, Mono, and Modoc Counties; with a single specimen from Victorville, Los Angeles County) and Nevada (Mineral and Washoe Counties).

Specimens examined.—Holotype: ♀, Irwin specimen number 1578, CAS type no. 10470; Batchelder Spring, Inyo Co., California; MEI; July 21, 1967; under *Salix* on rock. Paratopotypes: 3 ♀. Other paratypes: 3 ♂, 18 ♀. Other specimens: 10 ♂, 10 ♀. The following specimens were examined:

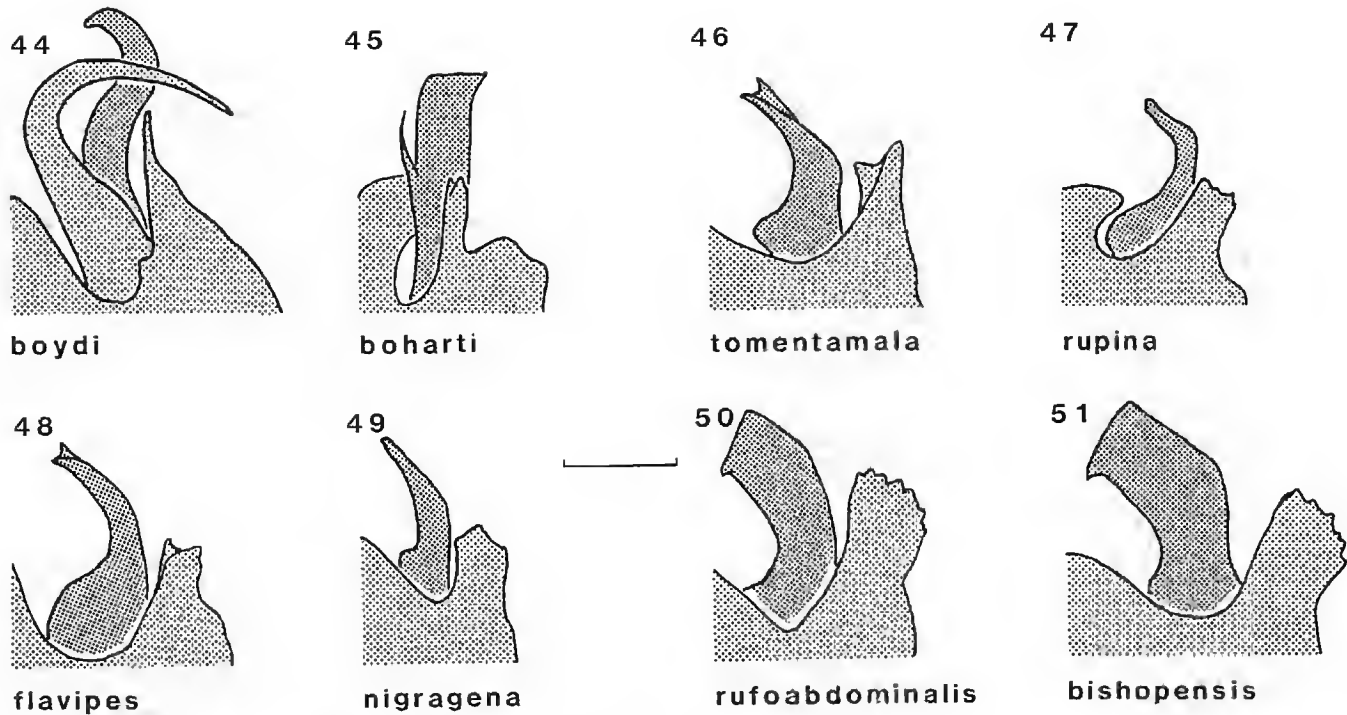
CALIFORNIA: Inyo Co.: Antelope Springs, 1675 m, 60/06/19, HKC, 4 ♂, 14 ♀; 60/06/20, HKC, 1 ♂, 2 ♀; 65/07/02, MEI, 3 ♂, 4 ♀; 67/07/21, MEI, 1 ♂; Batchelder Spring, 67/07/10, RMB, 1 ♀; 67/07/21, MEI, 3 ♀; Big Pine, 57/07/06, JW, 1 ♂; Lone Pine, 1.6 km N, 64/06/12, MEI, 1 ♀; Westgard Pass, 9.7 km E, 65/07/01, MEI, 1 ♀. Modoc Co.: Canby, NW of, 60/06/24, EIS, 1 ♀. Mono Co.: Topaz Lake, 57/06/26, JWM, 2 ♂. San Bernardino Co.: Victorville, 44/05/30, ALM, 1 ♂. NEVADA: Mineral Co.: Basalt, 6.4 km S, 65/07/01, MEI, 5 ♀. Washoe Co.: Patrick, 64/06/30, FDP, 1 ♂.

***Pherocera rufoabdominalis* Irwin, Sp. Nov.**

(Figs. 6-11, 18, 27, 35, 42, 50, 59)

Derivation of name.—*rufus* (Latin) = red or reddish; *abdomen* (Latin) = belly.

Diagnosis.—*P. rufoabdominalis* can be distinguished from all other species of the *boharti* group by the following combination of characters: abdomen red; mesonotal vittae indistinct; female frontal callosity as in Fig. 18, not reaching ocellar tubercle and being entirely bare (tomentose area only within callosity of *P. bishopensis* females); male terminalia with hypoproct as in Fig. 42 and ventral gonocoxal spur as in Fig. 50.



Figs. 44–51. Ventral gonocoxal spurs on outer lateroventral portions of gonocoxites (light shading) and gonostyli (dark shading) of male genitalia of *Pherocera boharti* group, ventrolateral view. 44, (1519); 45, (1635); 46, (1669); 47, (1787); 48, (1192); 49, (1594); 50, (3209); 51, (2639). Scale = 0.1 mm.

Description, female holotype.—See Table 1 for holotype measurements, Table 2 for discrete character states. Also see diagnosis of *boharti* group.

Head: Black; face and frons similar to Fig. 18; tomentum silver-gray on vertex and upper frons, silver on central and lower frons and gena. Pile lacking on ocellar tubercle; sparse, short, white dorsolaterad of antennal socket and lower gena, longer on palp. Ratio of antennal scape : pedicel : flagellum, 14:7:34; scape with two black setae ventrad; sparse, white pile over entire surface; pedicel with short, white pile forming distal ring; flagellum similar to Fig. 27, bare; entire antenna dark brown with whitish to light brown tomentum; palp (Fig. 35) light brown, translucent; proboscis dark brown.

Thorax: Black; mesonotal vittae indistinct but easily discernible; tomentum gray to gray-brown, denser on scutellum than mesonotum; mesonotal pile not evident on anterior portion, very sparse, white posteriorly, sparse on scutellum; pleural region densely silver tomentose except for katatergite and anepimeron; fine white pile on anepisternum and katatergite; coxae dark brown, silver tomentose and white pilose except for red cuticular coloration on distal $\frac{2}{3}$ of middle and distal $\frac{1}{4}$ of hindcoxae; legs red with femur, distal $\frac{1}{4}$ of tibia (proximal $\frac{3}{4}$ of tibia white), tarsus of foreleg, tarsus of midleg, and distal $\frac{1}{6}$ of tibia and tarsus of hindleg dark brown. Pile on legs white; wing veins brown.

Abdomen: Red; tomentum gray, almost nonexistent; pile short, white anteriorly to black posteriorly; tergites I–III fasciate.

Male.—Same as female holotype except as follows: pile short, black on posterior edge of ocellar tubercle; frons silver tomentose; mesonotum short, white pilose; pile longer, denser on scutellum; palp medium brown; coxae black; distal $\frac{1}{6}$ of middle tibia and distal $\frac{1}{4}$ of hindtibia dark brown. Aedeagus as in Fig. 59; hypoproct as in Fig. 42; ventral gonocoxal spur and gonostylus as in Fig. 50; aedeagus as in Fig. 59.

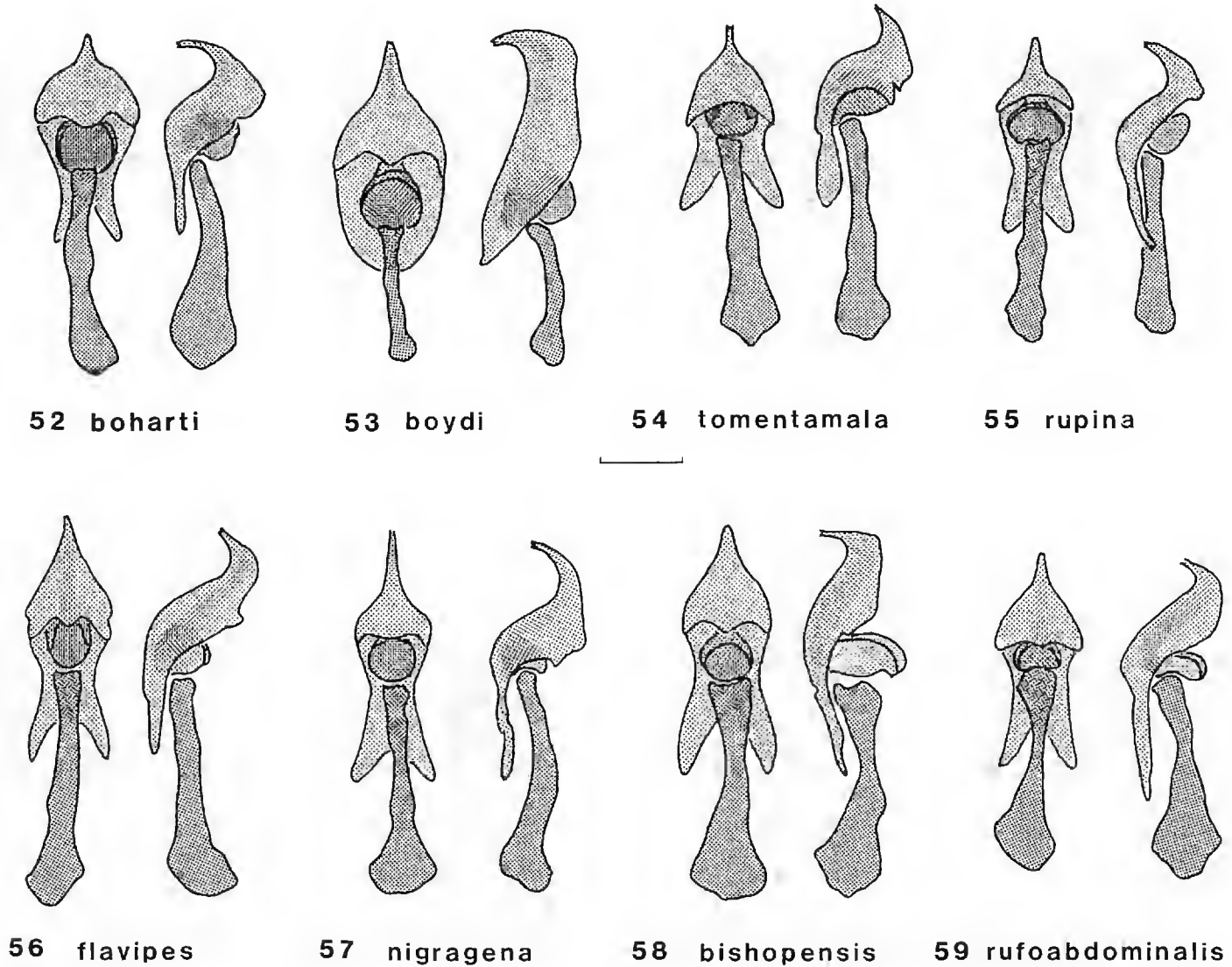
Variation.—Overall length 3.5 mm to 5.4 mm ♂; 3.7 mm to 5.8 mm ♀; with some brown tomentum above and lateral to female frontal callosity; sometimes tergite IV also fasciate.

Distribution and ecological placement.—*P. rufoabdominalis* is generally found within the confines of desert canyon bottom environments, closely associated with rock substrates and, when present, is often found under desert willow (*Chilopsis linearis*). It is found along the eastern side of the San Jacinto and Santa Rosa Mountains, Riverside County, California, the southeastern San Bernardino Mountains, San Bernardino County, California, the Santa Ana Mountains, Orange County, California, and the eastern slope of the Sierra Juarez Mountains, Baja California Norte, Mexico.

Specimens examined.—Holotype: ♀, Irwin specimen number 2626, CAS type no. 10475; P. L. Boyd Deep Canyon Desert Research Center, 6.4 km south of Palm Desert, Riverside Co., California; MEI; July 17, 1965; at Willow Pool (Marker O) on rock under willow tree (*Salix* sp.) in filtered light. Paratopotypes: 129 ♂; 153 ♀. Other topotypes: 119 ♂; 31 ♀. Other specimens: 4 ♂; 4 ♀. The following specimens were examined:

MEXICO: Baja California Norte: La Rumorosa, 14.5 km S, 1372 m, 67/07/08, MEI, 1 ♂.

USA—CALIFORNIA: Kern Co.: Walker Pass, 1585 m, 58/08/19, RHP EMP, 1 ♂. **Orange Co.:** Irvine Lake, 63/09/11, MEI, 1 ♂. **Riverside Co.:** Cottonwood Canyon, 69/07/30, SIF LFL, 1 ♀; P. L. Boyd Deep Canyon Desert Research Center, 6.4 km S Palm Desert, 63/06/21, EIS, 14 ♀; 63/07/11, EIS, 9 ♀; 63/07/26, EIS, 4 ♂, 8 ♀; 63/08/09, EIS, 1 ♂; 63/08/23, EIS, 4 ♂, 6 ♀; 63/09/23, MEI EIS, 1 ♀; 63/09/24, EIS, 3 ♂, 5 ♀; 63/10/09, EIS, 1 ♀; MEI, 3 ♀; 64/07/01, KWB, 1 ♀; 64/09/02, PAR, 5 ♂, 3 ♀; ARG, 1 ♀; 64/09/10, MEI, 1 ♂, 5 ♀; 69/06/07, SIF, 4 ♀; 69/06/13, SIF, 4 ♂, 1 ♀; 320 m, 64/06/24, EIS, 7 ♂, 5 ♀; 65/06/08, MEI, 1 ♂; 67/10/17, MEI, 1 ♂; 68/11/08, MEI, 6 ♂; 68/11/17, MEI, 3 ♂; 69/05/16, MEI, 1 ♂; 69/05/18, MEI, 7 ♂; 69/05/21, MEI, 1 ♂; 69/05/24, MEI SIF, 4 ♂, 1 ♀; 69/06/10, SIF, 2 ♀; 69/06/15, SIF RMW, 4 ♂, 6 ♀; 69/06/19, SIF RMW, 2 ♂, 1 ♀; 69/06/20, SIF RMW, 1 ♂; 69/06/23, SIF RMW, 2 ♂, 1 ♀; 69/05/25, SIF RMW, 4 ♂, 4 ♀; 69/06/27, SIF RMW, 2 ♂; 69/06/28, SIF RMW, 1 ♂; 69/06/29, SIF RMW, 2 ♂; 69/07/05, SIF RMW, 6 ♂, 1 ♀; 69/07/10, SIF RMW, 5 ♂; 69/07/13, SIF RMW, 1 ♂; 69/07/14, SIF RMW, 1 ♂; 69/07/15, SIF RMW, 1 ♂; 69/07/17, SIF RMW, 2 ♂; 69/07/18, SIF RMW, 6 ♂, 1 ♀; 69/07/22, SIF RMW, 1 ♂; 69/07/23, SIF RMW, 1 ♂; 69/07/25, SIF RMW, 3 ♂; 69/07/27, SIF RMW, 1 ♂; 69/07/29, SIF RMW, 2 ♀; 69/08/01, SIF RMW, 2 ♂, 2 ♀; 69/08/03, SIF RMW, 4 ♂, 3 ♀; 69/08/05, SIF RMW, 2 ♂, 1 ♀; 69/08/06, SIF RMW, 1 ♂; 69/08/09, SIF RMW, 1 ♂; 69/08/12, SIF RMW, 2 ♂, 1 ♀; 69/08/16, SIF RMW, 1 ♂; 69/08/17, SIF RMW, 1 ♂; 69/08/20, SIF RMW, 3 ♂; 69/08/22, SIF RMW, 6 ♂; 69/08/24, SIF RMW, 5 ♂, 1 ♀; SIF JT, 1 ♀; 69/08/25, SIF JT, 1 ♂; 69/08/26, SIF JT, 1 ♂; 69/09/01, SIF JT, 4 ♂; 69/09/05, SIF JT, 16 ♂, 1 ♀; 69/09/07, SIF MEI, 60 ♂, 16 ♀; 335 m, 64/09/10, EIS, 5 ♂; 366 m, 64/09/02, MEI, 1 ♂; 64/09/10, MEI, 1 ♂; EIS, 2 ♀; 67/05/19, MEI, 1 ♂; 373 m, 64/06/24, EIS, 2 ♀; 64/09/02, MEI, 8 ♂, 6 ♀; 64/09/10, MEI, 10 ♂, 3 ♀; 65/06/08, MEI, 1 ♀; 69/08/25, SIF, 2 ♂, 2 ♀; 381 m, 64/09/02, MEI, 1 ♂, 6 ♀; 64/09/10, MEI, 1 ♂; 69/06/13, SIF, 1 ♂; 69/06/29, SIF, 1 ♀; 400 m, 64/05/31, MEI, 1 ♀; 64/07/08, EIS, 1 ♀; 65/07/17, MEI, 3 ♂, 3 ♀; 64/09/02, MEI, 1 ♂, 7 ♀; 64/09/10, MEI, 1



Figs. 52–59. Aedeagi of male genitalia of *Pherocera boharti* group, dorsal (left) and lateral (right) views. 52, (1635); 53, (1519); 54, (1669); 55, (1787); 56, (1192); 57, (1594); 58, (2639); 59, (3209). Scale = 0.1 mm.

♀; **410 m**, 64/07/01, EIS, 1 ♂; 64/07/08, EIS, 1 ♂; 64/09/02, MEI, 4 ♂, 8 ♀; **420 m**, 64/07/23, MEI, 1 ♀; **434 m**, 64/09/02, MEI, 4 ♂, 11 ♀; 64/09/10, EIS, 2 ♂, 4 ♀; **1036 m**, 65/06/11, MEI, 2 ♀. **San Bernardino Co.:** Morongo, 44/09/26, ALM, 2 ♀. **San Diego Co.:** Culp Canyon, Anza-Borrego State Park, 58/06/12, EIS, 1 ♀; junction of highways 78 and S2, 65/08/07, SIF SLF SL, 1 ♂.

***Pherocera rupina* Irwin, Sp. Nov.**

(Figs. 1–5, 15, 23, 31, 39, 47, 55)

Derivation of name.—*rupina* (Latin) = rocky chasm.

Diagnosis.—*P. rupina* can be distinguished from all other species of the *boharti* group by the following combination of characters: Palp light brown to tan; female frontal callosity as in Fig. 15; legs almost entirely dark brown to black; male terminalia with hypoproct as in Fig. 39 and ventral gonocoxal spur and gonostylus as in Fig. 47.

Description, female holotype (Fig. 1).—See Table 1 for holotype measurements, Table 2 for discrete character states. Black; silver tomentose; white pilose.

Head: Face and frons similar to Fig. 15; frontal callosity slightly less pointed ventrally; pile absent on ocellar tubercle, short, sparse dorsolaterad of antennal socket, short posterior to genal stripe, longer on palp; ratio of antennal scape: pedicel: flagellum, 16:8:35; scape with two black setae ventrad, pilose; pedicel

sparsely pilose; flagellum similar to Fig. 23, smoother, bare; antenna dark brown; palp (Fig. 31) tan; proboscis black.

Thorax: Mesonotal vittae indistinct but discernible; mesonotal pile short, sparse; pleural region tomentose except for katatergite and anepimeron; anepisternum and katatergite long pilose; coxae tomentose, pilose; legs white pilose, dark brown with proximal $\frac{3}{4}$ of foretibia white; wing veins light brown.

Abdomen: Tomentum absent dorsally, relatively dense ventrally; tergites I-III relatively long pilose and fasciate; rest of abdomen with shorter, sparse pile.

Male.—Same as female holotype except as follows: pile dorsolaterad of antennal socket longer, denser; legs brown or black with foretibia white; pile relatively long on abdominal tergites; aedeagus as in Fig. 55; hypoproct as in Fig. 39; ventral gonocoxal spur and gonostylus as in Fig. 47.

Variation.—Overall length 3.1 mm to 4.7 mm ♂; 3.5 mm to 5.3 mm ♀; genal stripe occasionally lightly powdered with tomentum; the populations from Baja California Sur, Mexico, and some southern California specimens have three or four black setae on antennal scape.

Distribution and ecological placement.—*P. rupina* was collected repeatedly on rock substrates in desert canyon bottom environments in Riverside County, California and in Baja California Sur and Norte, Mexico.

Specimens examined.—Holotype: ♀, Irwin specimen number 1725, CAS type no. 10476; P. L. Boyd Deep Canyon Desert Research Station, 6.4 km south of Palm Desert, Riverside Co., California; MEI; June 8, 1965; at marker 56.8 on rock in filtered light under *Chilopsis*, not near water, in sunny area in light wind. Paratopotypes: 188 ♂; 94 ♀. Other topotypes: 9 ♂. Other specimens: 48 ♂, 13 ♀. The following specimens were examined:

MEXICO: Baja California Norte: San Quintin, inland from, 55/05/25, FXW, 1 ♀. **Baja California Sur:** Guadalupe, 100 km NW of La Paz, 107 m, 68/04/20, MEI, 7 ♂; Loreto, 8 km W, 15 m, 68/04/17, MEI, 1 ♂, Santa Rosalia, 40 km S, 10.7 m, 68/04/15, MEI, 2 ♂.

USA-CALIFORNIA: Riverside Co.: Massacre Canyon at highway 79, 64/07/29, MEI, 25 ♂, 1 ♀; PAR, 5 ♂, 7 ♀; 64/07/30, MEI, 7 ♂; MacCoy Springs, 63/04/08, JCH, 1 ♀; P. L. Boyd Desert Research Center, 6.4 km S of Palm Desert, 63/05/03, EIS, 7 ♂, 6 ♀; 63/05/17, EIS, 5 ♂, 2 ♀; 63/05/30, EIS, 3 ♀; 63/06/21, EIS, 1 ♂; 63/07/11, EIS, 3 ♂, 1 ♀; 63/07/21, EIS, 5 ♂; 63/07/26, EIS, 3 ♂; 63/09/05, EIS, 1 ♀; 63/09/24, EIS, 8 ♂; 64/05/09, MEI, 1 ♂; 64/07/01, KWB, 3 ♂, 1 ♀; 69/06/07, SIF, 4 ♂; 320 m, 64/05/09, MEI, 2 ♂; 64/05/25, MEI, 2 ♂; 64/06/24, EIS, 7 ♀; 64/07/01, EIS, 1 ♀; 64/07/23, MEI, 3 ♂; 64/09/10, MEI, 1 ♂; 65/06/08, MEI, 3 ♂, 5 ♀; 65/07/17, MEI, 1 ♂; 67/10/17, MEI, 2 ♂; 68/09/08, MEI, 4 ♂, 2 ♀; 69/05/18, MEI, 8 ♂, 3 ♀; 69/05/21, MEI, 1 ♂, 2 ♀; 69/05/24, MEI SIF 10 ♂, 7 ♀; 69/06/10, SIF, 2 ♀; 69/06/15, SIF RMW, 2 ♂, 9 ♀; 69/06/19, SIF RMW, 3 ♀; 69/06/20, SIF RMW, 1 ♀; 69/06/23, SIF RMW, 1 ♂, 1 ♀; 69/06/25, SIF RMW, 1 ♀; 69/06/27, SIF RMW, 1 ♂; 69/06/29, SIF RMW, 1 ♂, 1 ♀; 69/07/01, SIF RMW, 2 ♂; 69/07/02, SIF RMW, 1 ♂; 69/07/05, SIF RMW, 2 ♂, 1 ♀; 69/07/10, SIF RMW, 1 ♂; 69/07/13, SIF RMW, 1 ♂; 69/07/15, SIF RMW, 1 ♂; 69/07/22, SIF RMW, 1 ♂; 69/08/24, SIF RMW, 1 ♂; 69/09/07, SIF MEI, 2 ♂; 335 m, 65/06/08, MEI, 2 ♂; 343 m, 64/05/19, MEI, 7 ♀; 64/06/24, EIS, 30 ♂; 64/07/01, EIS, 12 ♂; 64/09/10, MEI, 1 ♂; 65/06/08, MEI, 4 ♂; 350 m, 64/09/10, MEI, 2 ♂; 65/06/08, MEI, 2 ♂; 358 m, 65/06/08, MEI, 1 ♂; 366 m, 63/09/10, EIS, 1 ♂; 64/05/31, MEI, 4 ♂; 64/09/02,

MEI, 4 ♂; 64/09/10, MEI, 2 ♂; 65/06/08, MEI, 1 ♂, 1 ♀; **373 m**, 64/05/19, MEI, 3 ♀; 64/05/31, MEI, 1 ♀; 64/09/02, MEI, 2 ♀; 64/09/10, MEI, 2 ♂, 3 ♀; 65/06/08, MEI, 1 ♂; **381 m**, 64/09/02, MEI, 1 ♂; **400 m**, 64/05/09, MEI, 8 ♂; 64/05/19, MEI, 4 ♀; 64/06/24, EIS, 1 ♀; 64/07/08, EIS, 7 ♂, 2 ♀; 64/09/02, MEI, 2 ♀; 65/04/28, MEI, 1 ♂; 65/06/08, MEI, 2 ♀; 65/07/17, MEI, 3 ♂; **412 m**, 64/05/31, MEI, 5 ♂; 64/07/01, EIS, 1 ♂; 64/07/08, EIS, 6 ♂; **420 m**, 67/05/19, MEI, 2 ♀; **434 m**, 64/09/02, MEI, 1 ♀; 64/09/10, EIS, 1 ♀. Winchester, 68/06/20, WI, 1 ♀. **San Diego Co.:** Culp Canyon, Anza-Borrego State Park, 58/06/26, EIS, 1 ♀.

***Pherocera tomentamala* Irwin, SP. NOV.**

(Figs. 14, 22, 30, 38, 46, 54)

Derivation of name.—*tomentum* (Latin) = wooly hairs; *mala* (Latin) = jaw.

Diagnosis.—*P. tomentamala* can be distinguished from all other species of the *boharti* group by the following combination of characters: female frontal callosity as in Fig. 14; mesonotum with indistinct vittae; genal stripe lacking; male terminalia with hypoproct as in Fig. 38 and ventral gonocoxal spur as in Fig. 46.

Description, female holotype.—See Table 1 for holotype measurements, Table 2 for discrete character states. Dark brown; tomentum silver; pile white.

Head: Face and frons as in Fig. 14; pile lacking on frons, very sparse on posterior portion of lower gena, elongate on palp; ratio of antennal scape : pedicel : flagellum, 15:7:39; scape with two elongate black setae ventrad and white pilose overall; pedicel very sparsely pilose; flagellum similar to Fig. 22; bare; antenna, palp (Fig. 30) and proboscis brown.

Thorax: Mesonotal vittae indistinct but discernible; mesonotal pile short, sparse; pleural region tomentose except for katatergite and anepimeron; anepisternum and katatergite pilose; coxae tomentose, white pilose; legs orange with ventral proximal $\frac{1}{4}$ of femora, distal $\frac{1}{5}$ of tibiae and tarsi of mid and hindlegs black; foreleg entirely black except for proximal $\frac{2}{3}$ of tibia white and joint between femur and tibia orange; legs predominantly white pilose, distal $\frac{1}{3}$ of foretibia short, black pilose; wing veins light brown.

Abdomen: Tomentum absent dorsally, sparse ventrally; pile moderate, covering entire abdomen; tergites I–II fasciate.

Male.—Same as female holotype except as follows: abdominal pile longer; aedeagus as in Fig. 54; hypoproct as in Fig. 38; ventral gonocoxal spur and gonostylus as in Fig. 46.

Variation.—Overall length 4.9 mm to 5.2 mm ♂; 5.0 mm ♀.

Distribution and ecological placement.—*P. tomentamala* has been collected in association with dead twigs under *Cercidium* trees on inland stable sand dunes and in cotton fields. Although only eight specimens are presently known, they indicate a wide distributional range from Imperial, Riverside, and San Bernardino Counties in California and Maricopa County in Arizona.

Specimens examined.—Holotype: ♀, Irwin specimen number 1670, CAS type no. 10480; 10 km north of Glamis, Algodones Dunes, Imperial Co., California at **100 m**; MEI; May 21, 1967; under *Cercidium* tree. Paratypes: 3 ♂, 1 ♀. Other specimens: 2 ♂, 1 ♀. The following specimens were examined:

ARIZONA: **Maricopa Co.:** Gila Bend, 11.3 km NW, **215 m**, 61/04/10, RHP EMP, 1 ♂. CALIFORNIA: **Imperial Co.:** Calexico, 57/07/11, collector unknown,

1 ♀; Glamis, 10 km N, **100 m**, 67/05/21, MEI, 1 ♀. Holtville, nr., 75/08/10, GRB, 1 ♂, 1 ♀. **Riverside Co.:** Indio, Keosegan Ranch, 70/07/15, MEI, 1 ♂; 70/07/26, MEI, 1 ♂. **San Bernardino Co.:** Oro Grande, 54/06/16, collector unknown, 1 ♂.

LITERATURE CITED

- Cole, F. R. 1923a. A revision of the North American two-winged flies of the family Therevidae. *Proc. U.S. Natl. Mus.* 62:1-140.
- . 1923b. Expedition of the California Academy of Sciences to the Gulf of California in 1921. Diptera from the islands and adjacent shores of the Gulf of California. II. General Report. *Proc. Calif. Acad. of Sci., Series 4*, 12:457-481.
- . 1965. Family Therevidae, pp. 348-354. *In*: A. Stone, C. W. Sabrosky, W. W. Wirth, R. H. Foote, and J. R. Coulson, eds., *A catalog of the Diptera of America north of Mexico*. U.S. Dept. Agr. Handbook 276. Washington, D.C., 1696 pp.
- Cole, F. R., and E. I. Schlinger. 1969. *The flies of western North America*. Univ. Calif. Press, Berkeley & Los Angeles, 693 pp.
- Hardy, G. H. 1927. On the phylogeny of some Diptera Brachycera. *Proc. Linn. Soc. New South Wales* 52:380-386.
- Irwin, M. E. 1971. Ecology and biosystematics of the pherocerine Therevidae. Ph.D. Dissertation in Entomology, Univ. of Calif., 256 pp.
- . 1973. A new genus of the *Xestomyza*-group from the western coast of South Africa, based on two new species with flightless females (Diptera: Therevidae). *Ann. Natal Mus.* 21:533-556.
- . 1976. Morphology of the terminalia and known ovipositing behavior of female Therevidae (Diptera: Asiloidea), with an account of correlated adaptations and comments on phylogenetic relationships. *Ann. Natal Mus.* 22:913-935.
- . 1977. Two new genera and four new species of the *Pherocera*-group from western North America, with observations on habitats and behavior (Diptera: Therevidae: Phycinae). *Proc. Ent. Soc. Wash.* 79:422-451.
- Irwin, M. E., and L. Lyneborg. 1981a. The genera of Nearctic Therevidae. *Bull. Ill. Natur. Hist. Surv.* 32:191-277.
- . 1981b. Family Therevidae, Chapter 37, pp. 513-523. *In*: J. F. McAlpine, B. V. Peterson, G. E. Shewell, H. J. Teskey, J. R. Vockeroth, D. M. Wood, coordinators, *Manual of Nearctic Diptera*. Agr. Canada Monogr. 27. Ottawa, Ontario, Vol. 1, 674 pp.
- Lyneborg, L. 1968. A comparative description of the male terminalia in *Thereva* Latr., *Dialineura* Rond., and *Psilocephala* Zett. (Diptera, Therevidae). *Ent. Medd.* 36:546-559.
- . 1972. A revision of the *Xestomyza*-group of Therevidae (Diptera). *Ann. Natal Mus.* 21:297-376.
- McAlpine, J. F., B. V. Peterson, G. E. Shewell, H. J. Teskey, J. R. Vockeroth, and D. M. Wood. 1981. *Manual of Nearctic Diptera*. Agr. Canada Monogr. 27. Ottawa, Ontario, Vol. 1, 674 pp.
- Rauch, P. A. 1970. Electronic data processing for entomological museums, an economical approach to an expensive problem. Ph.D. Dissertation in Entomology, Univ. of Calif., 78 pp.
- Rodendorf, B. B. 1964. Historical development of two-winged insects [in Russian]. *Proc. Acad. Sci. U.S.S.R. (Paleontological Institute)* 100:1-311.
- Stuckenberg, B. R., and M. E. Irwin. 1973. Standards for entomological labels. *Bull. Ent. Soc. Amer.* 19:164-168.
- Torre-Bueno, J. R. de la. 1950. *A glossary of entomology*. Brooklyn Ent. Soc., Brooklyn, N.Y., 336 pp.

Review of the Euchroeine Chrysidids
(Hymenoptera: Chrysididae)

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The Euchroeini contains some of the more highly modified and unusual-looking genera in the Chrysididae. The taxonomy of this group has long been confused and as many as 20 different generic names have been used. Included in the Euchroeini are the largest chrysidids, members of the genus *Stilbum*, reaching up to 25 mm in length. Although Euchroeini is primarily an Old World group, 2 species of *Spinolia* are found in the New World, and *Neochrysis* is strictly neotropical.

I am following the higher classification proposed by Bohart and Kimsey (1980) and Kimsey and Bohart (1981). Members of the Euchroeini are distinguished by their characteristic wing venation: the forewing radial sector extends over half the length of the marginal cell and bends slightly away from the coastal margin. Based on this characteristic 5 genera are included: *Euchroeus*, *Stilbichrysis*, *Spinolia*, *Stilbum* and *Neochrysis*.

This study is intended as a preliminary reorganization of the generic taxonomy of these chrysidids in preparation for a more detailed cladistic analysis of the chrysidid genera.

Under each genus I give a preliminary list of included species. These lists are based on Linsenmaier (1959, 1968), Mocsáry (1889), original descriptions and examination of types, as indicated by an asterisk. Some names in the lists may prove to be synonyms as I have not seen all of the types. Host and distributional data are summarized in Table 1 and Fig. 1, respectively. Male genitalia are not particularly useful in this group at the generic level, except to distinguish *Neochrysis*.

The following abbreviations are used: RS = radial sector, 1A = anal vein, Cu = cubital vein, T = gastral tergum, S = gastral sternum, and MOD = midocellus diameter.

This paper is dedicated to Richard M. Bohart who has done more to straighten out the taxonomy of the Chrysididae than any other systematist living or dead.

KEY TO GENERA OF EUCHROEINI

- 1. Metanotum produced posteriorly into large spoon-like projection (Fig. 5); least frontal width less than eye width in front view (Fig. 2); T-III with 4 symmetrical apical teeth *Stilbum* Spinola
- Metanotum not produced into spoon-like projection, least frontal width usually greater than eye width, T-III variable 2
- 2. Hindwing with 3 sclerotized veins and M+Cu forked; scutellum elevated above level of scutum and metanotum; metanotal surface irregular and denticulate *Stilbichrysis* Bischoff
- Hindwing with 2 or fewer sclerotized veins and M+Cu, not forked or

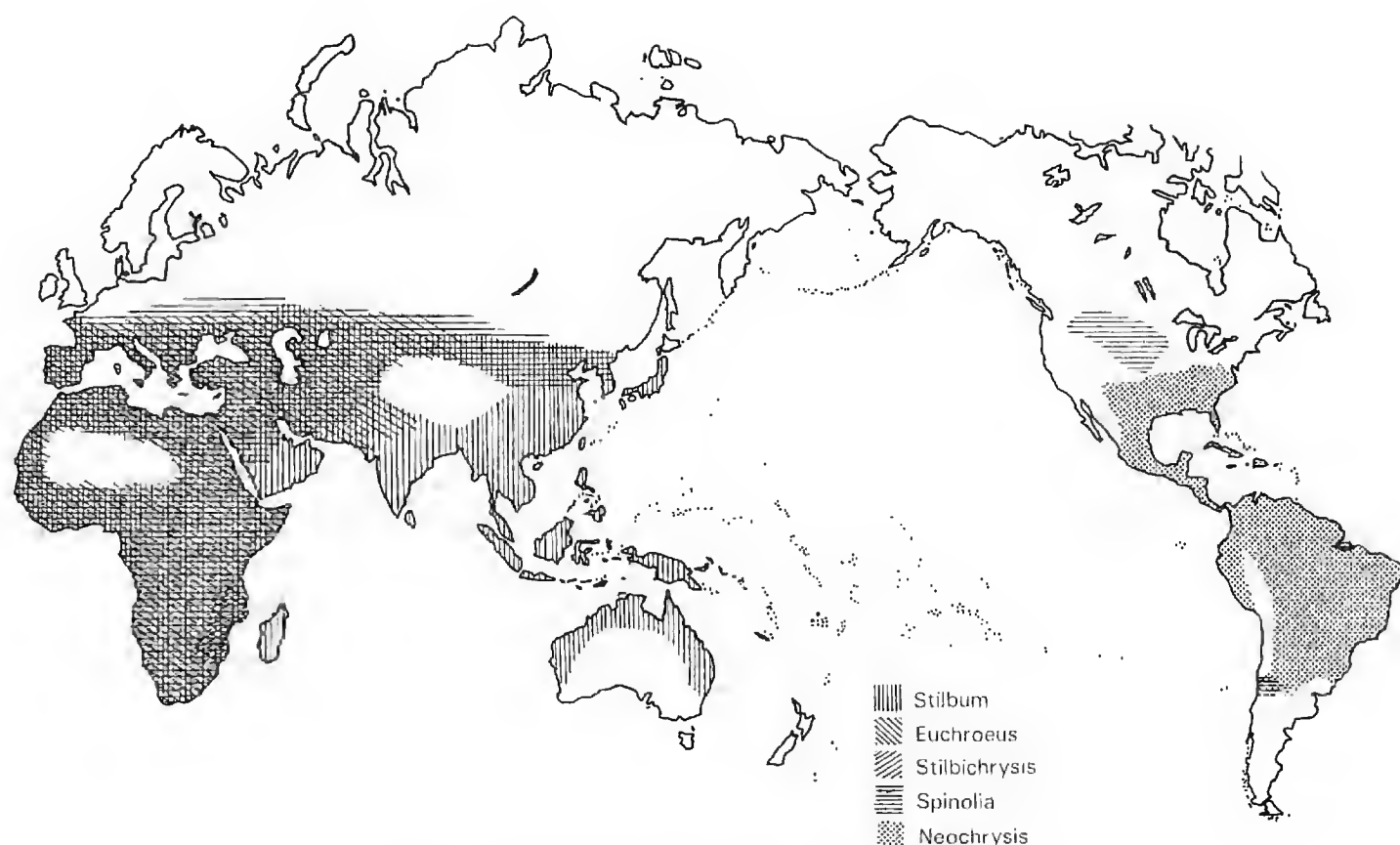


Fig. 1. Distribution map of euchroeine genera.

- absent; scutellum not elevated above level of scutum and metanotum;
metanotal surface relatively even and smooth 3
3. Mesopleuron with 2 large teeth pointing ventrally, similar to Fig. 6; T-III
dentate, with 8 or more asymmetrical teeth or more rarely 4 white teeth
..... *Euchroeus* Latreille
- Mesopleuron without 2 large teeth pointing ventrally; T-III with 2, 4 or
6 symmetrical, non-white teeth (as in Fig. 8) or edentate 4
4. T-III with 4 or 6 apical teeth *Neochrysis* Linsenmaier
- T-III apical rim edentate, with small irregularities or with 2 small lateral
teeth *Spinolia* Dahlbom

Euchroeus Latreille

Chrysis Linnaeus, in part.

Euchroeus Latreille, 1809:578. Type species: *Chrysis purpurata* Fabricius, 1787.

Brugmoia Radoszkowski, 1877:26. Type species: *Brugmoia pellucida* Radoszkowski, 1877, orig. desig.

Brugmoja Radoszkowski, 1877:pl. 2, fig. 12. Misspelling of *Brugmoia*.

Polyodontus Radoszkowski, 1877:25. Type species: *Polyodontus stchurovsky* Radoszkowski, 1877, orig. desig.

Euchroeides Nurse, 1904:23. Type species: *Euchroeides oblatus* Nurse, 1904, by monotypy.

Afrospinolia Linsenmaier, 1968:42. Type species: *Euchroeus katanganus* Linsenmaier, 1968, orig. desig. (treated as subgenus of *Euchroeus*). **New synonymy.**

Diagnosis.—Malar space 1.0 MOD long or usually longer; face with transverse frontal carina (Fig. 3); tongue as long as eye height or longer; mesopleuron with transverse medial groove and 2 or more sharp teeth pointing ventrally; metanotum evenly rounded; T-I anterior corners rounded; T-III apically with more than 8

Table 1. Hosts of euchroeine species.

Euchroeine species	Host species	Family	Author
<i>Stilbum cyanurum</i>	<i>Sceliphron destillatorium</i> Illig.	Sphecidae	Grandi, 1961
	<i>Eumenes unguiculatus</i> Villers	Eumenidae	
	<i>Sceliphron</i> sp.	Sphecidae	Zimmermann, 1937
	<i>Eumenes</i> sp.	Eumenidae	
	<i>Odynerus</i> sp.		
	<i>Rhynchium</i> sp.		
	<i>Chalcidoma</i> sp.	Megachilidae	
	<i>Megachile</i> sp.		
<i>S. viride</i>	<i>Eumenes maxillosus</i> DeGeer	Eumenidae	Linsenmaier, 1959
<i>Spinolia neglectus</i>	<i>Odynerus spinipes</i> (Linnaeus)		
	<i>Odynerus reniformis</i> (Gmelin)		
<i>S. humboldti</i>	<i>Paravespa grandis</i> Morice		Summarized in Bohart and Kimsey, 1980
<i>S. dallatorreanus</i>	<i>Pterocheilus bembeciformis</i>		
<i>S. lamprosomus</i>	<i>Odynerus spiricornis</i> (Spinola)		
<i>Neochrysis</i> sp.	<i>Podium</i> sp.	Sphecidae	
	<i>Trypoxylon</i> sp.		
	<i>Sceliphron</i> sp.		

irregular teeth or denticles (Fig. 9) (except *singularis*), and apical rim and teeth often at least partly white or transparent; female T-V and S-V unmodified (as in Figs. 11, 12).

Distribution (Fig. 1).—Europe and the Middle East, south to South Africa.

Included species.—*artifrons* Edney 1947*, *aurovirens* (Mocsáry) 1913 (*Chrysis*), *binodatus* Edney 1947*, *candens* Dahlbom 1845, *chrysidiformis* Magretti 1898, *doursi* Gribodo 1875, *egregius* Buysson 1887, *eos* (Semenov) 1954 (*Chrysis*), *hellenicus* (Mocsáry) 1913 (*Chrysis*)*, *jordanicus* Linsenmaier 1968, *katanganus* Linsenmaier 1968, *limbatus* Dahlbom 1854*, *mongolicus* Tsuneki 1947, *moricei* Buysson 1896*, *oblatus* (Nurse) 1904 (*Euchroeides*)*, *oculatissimus* Buysson 1898, *pellucidus* (Radozskowski) 1877 (*Brugmoia*), *purpuratus* (Fabricius) 1787 (*Chrysis*)*, *rugulosus* (Mocsáry) 1909 (*Chrysis*)*, *singularis* (Spinola) 1838 (*Chrysis*)*, *stchurovsky* (Radozskowski) 1877 (*Polyodontus*).

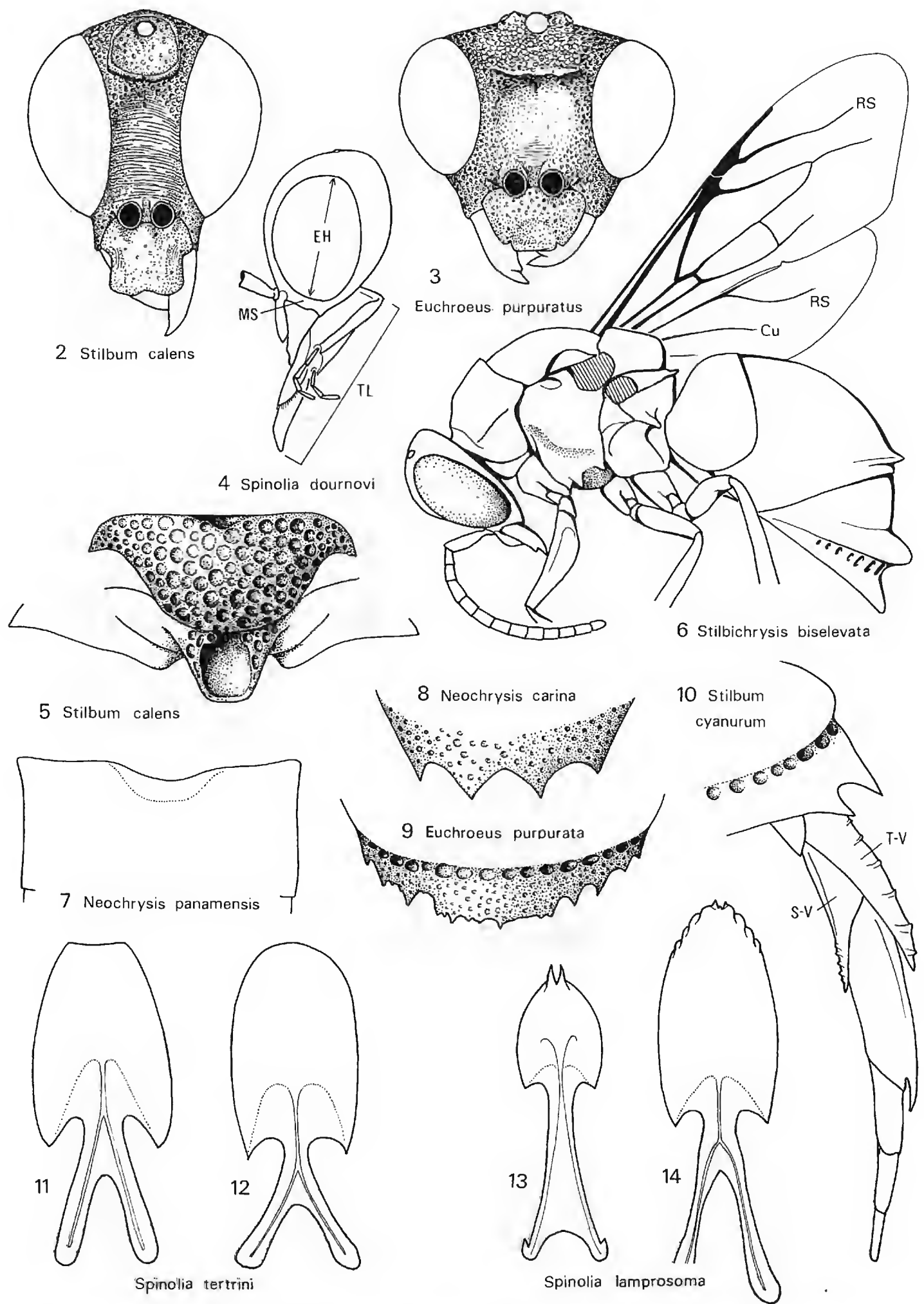
Discussion.—Members of *Euchroeus* can be readily distinguished from other chrysidids by the dentate mesopleuron and numerous irregular teeth along the apical rim of T-III. One exception to this is the species *singularis*, which has roughly 4 symmetrically arranged white teeth. Other characteristics of this species including the mesopleural teeth, long malar space and unmodified female T-V and S-V, definitely place *singularis* in *Euchroeus*. Another distinctive feature that occurs in several species, including *singularis* and *candens*, is the white coloration on the apical rim of T-III. This characteristic also occurs in *Neochrysis* (*Ipsiura*), *Argochrysis* and *Spintharosoma*, the latter 2 belonging in the Chrysidini.

Euchroeus species are rarely encountered; *purpuratus*, a European wasp, is probably the most commonly collected.

Neochrysis Linsenmaier

Chrysis Linnaeus, in part.

Neochrysis Linsenmaier 1959:74. Type species: *Chrysis punctatissima* Spinola,



Figs. 2-14. 2, 3, Male face, front view. 4, Female head, lateral view: eye height (EH), malar space (MS), tongue length (TL). 5, Scutellum, metanotum and propodeum, dorsal view. 6, Male body, lateral view: radial sector (RS), cubital vein (Cu), mesopleural teeth (MT). 7, Tergum I, dorsal view. 8, 9, Male tergum III, apical rim. 10, Ovipositor, lateral view. 11-14, Ovipositor segments. 11, 13, Tergum V, dorsal view. 12, 14, Sternum V, ventral view.

1840, orig. desig., nec Villers 1789 = *carina* Brullé, 1846 (treated as subg. of *Chrysis*).

Neochrysis Linsenmaier, Bohart 1966 (elevated to genus).

Pleurocera Guérin 1842: 149. Preocc. by *Pleurocera* Rafinesque, 1818. Type species: *Pleurocera viridis* Guérin, 1842 (nec Oliver, 1790) = *Chrysis bruchi* Brèthes, 1902, by monotypy.

Pleurochrysis Bohart 1966:144, n.n. for *Pleurocera* Guérin (treated as subg. of *Neochrysis* by Bohart and herein).

Exochrysis Bohart 1966:141. Type species: *Chrysis panamensis* Cameron, 1888, orig. desig. (treated as subg. of *Neochrysis* by Bohart and herein).

Ipsiura Linsenmaier 1959:74. Type species: *Chrysis marginalis* Brullé, 1846, orig. desig. (treated as subg. of *Neochrysis* by Bohart and herein).

Diagnosis.—Malar space 1.5 MOD long or less, tongue length usually shorter than eye height, mesopleuron without medial groove, T-I anterior corners sharply angled (Fig. 7), T-III with 4 or 6 symmetrical apical teeth (Fig. 8), female T-V and S-V unmodified or T-V with small ridge-like annulations, male paramere divided into a distinct, articulated telomere and basomere.

Distribution (Fig. 1).—Western Hemisphere, the southern half of the United States south to Chile and Argentina.

Discussion.—See Bohart and Kimsey (1980) and Kimsey and Bohart (1981) for discussion of generic and subgeneric taxonomy and included species. The male genitalia of *Neochrysis* is unique in the Eucharoeini due to the articulated telomere.

***Spinolia* Dahlbom**

Chrysis Linnaeus, in part.

Euchroeus Latreille, in part.

Holochrysis of Mocsáry, in part.

Pseudochrysis of Balthasar and Trautmann, in part.

Spinolia Dahlbom 1854:363. Type species: *Chrysis magnifica* Dahlbom, 1854, orig. desig. (= *lamprosoma* Förster, 1853).

Gonochrysis Lichtenstein 1876:227. Type species: *Chrysis albipennis* Dahlbom, 1854 (= *unicolor* Dahlbom, 1831).

Achrysis Semenov 1892:486. Type species: *Chrysis unicolor* Dahlbom, 1831 (treated as subg. of *Pseudochrysis*).

Spinolaia Schulz 1906:154, emendation of *Spinolia*.

Pseudospinolia Linsenmaier 1951:31. Type species: *Chrysis uniformis* Dahlbom, 1854, orig. desig. (treated as subg. of *Euchroeus*). **New synonymy.**

Neospinolia Linsenmaier 1968:39. Type species: *Chrysis tertrini* Buysson, 1897, orig. desig. (treated as subg. of *Euchroeus*). **New synonymy.**

Pseudospinolia Linsenmaier, Bohart and Kimsey, 1980, elevated to genus.

Diagnosis.—Malar space 1.0 MOD long or shorter (Fig. 4); tongue as long as eye height or longer (Fig. 4) (except *tertrini*); mesopleuron with transverse medial groove and without teeth or knobs; metanotum evenly rounded; T-I anterior corners rounded; T-III apical rim smooth or with slight irregularities and rounded, some species with 2 small lateral teeth.

Distribution (Fig. 1).—Palearctic, Africa, 1 species reaching North America (*neglectus*) and 1 in Chile (*tertrini*).

Included species. — *ardens* (Mocsáry) 1902 (*Chrysis*)*, *aureicollis* (Abeille) 1878 (*Chrysis*)*, *bouvieri* (Buysson) 1897 (*Chrysis*)*, *chalcites* (Mocsáry) 1890 (*Chrysis*)*, *chobauti* (Buysson) 1891 (*Chrysis*)*, *dallatorreanus* (Mocsáry) 1896 (*Chrysis*)*, *dournovi* (Radozskowski) 1866 (*Chrysis*)*, *gestroi* (Gribodo) 1874 (*Chrysis*), *gratiosus* (Mocsáry) 1889 (*Chrysis*), *herodianus* Morice 1909, *humboldti* (Dahlbom) 1845 (*Chrysura*)*, *ignithorax* (Balthasar) 1853 (*Pseudochrysis*), *incrassatus* (Spinola) 1838 (*Chrysis*), *insignis* (Lucas) 1849 (*Chrysis*), *lamprosomus* (Förster) 1853 (*Chrysis*)*, *marqueti* (Buysson) 1887 (*Chrysis*)*, *morawitzi* (Mocsáry) 1889 (*Chrysis*)*, *neglectoides* Linsenmaier 1959 **NEW COMB.**, *neglectus* (Shuckard) 1837 (*Chrysis*)*, *pulawskii* Linsenmaier 1968, *rogenhoferi* (Mocsáry) 1889 (*Chrysis*)*, *rugosa* Buysson 1900, *tertrini* (Buysson) 1897 (*Chrysis*)*, *theresia* (Buysson) 1900 (*Chrysis*)* **NEW COMB.**, *transversus* (Dahlbom) 1854 (*Chrysis*), *tricoloricornis* Linsenmaier 1968 **NEW COMB.**, *unicolor* (Dahlbom) 1831 (*Chrysis*)*, *uniformis* (Dahlbom) 1854 (*Chrysis*)*, *vogti* (Trautmann) 1926 (*Pseudochrysis*).

Discussion. — Linsenmaier (1959, 1968) placed the euchroeine species without apical teeth on T-III in 6 subgenera, *Spinolia*, *Pseudospinolia*, *Stilbichrysis*, *Primachroeus*, *Neochrysis*, *Prospinolia* and *Neospinolia*, which he included in *Euchroeus*. *Primachroeus* actually belongs in the Chrysidini, based on the position of the RS vein. The remaining subgenera were distinguished by the structure of the mesopleuron, length of the malar space, presence or absence of a transverse frontal carina on the face and the structure of T-II and T-III. In the case of *Neochrysis* and *Stilbichrysis* this approach is too conservative as these groups differ sufficiently to require generic status. After examining additional species from Africa it has become apparent that there are no clear-cut differences between the remaining subgenera. The elevation of *Pseudospinolia* to generic status by Bohart and Kimsey (1980) was premature. Characteristics such as the mesopleural sculpture, transverse frontal carina, pronotal carina and modification of the female ovipositor segments (T-V and S-V) vary too inconsistently between species to distinguish subgenera (see Table 2). As a result, I am synonymizing these names under *Spinolia* Dahlbom, which has priority.

Stilbichrysis Bischoff

Stilbichrysis Bischoff 1910:445. Type species: *Stilbichrysis biselevata* Bischoff, 1910, orig. desig.

Diagnosis. — Body, lateral view (Fig. 6), face with frontal carina, tongue longer than eye height, malar space about 1.0 MOD long, mesopleuron with 2 teeth and strong medial groove, hindwing with well developed RS, M+Cu and 1A veins, scutellum elevated, metanotum elevated with medial tooth, T-I anterior corners rounded, T-III apical rim smooth and rounded; female T-V and S-V apically with large ridge-like annulations (as in Fig. 10).

Distribution (Fig. 1). — Africa: Zimbabwe, Mozambique, South Africa and Tanzania.

Included species. — *biselevata* Bischoff 1910*, *serrulata* (Edney) 1947 (*Chrysis*)* **NEW COMB.**

Discussion. — Both of these species are rarely collected; they superficially resemble *Stilbum* but can be distinguished from it and other euchroeine genera by: T-III rim edentate, metanotum denticulate, malar space short, mesopleuron dentate and grooved and hindwing with sclerotized M+Cu and 1A veins.

Table 2. Morphological characteristics of selected species of *Spinolia* representing 3 subgenera according to Linsenmaier (1959, 1968).

Characteristics	Species												Sub-genus <i>Neo-spinolia</i>
	Subgenus <i>Spinolia</i> s.s.					Subgenus <i>Pseudospinolia</i>							
	<i>dallatorreanus</i>	<i>dournovi</i>	<i>lamprosoma</i>	<i>rugosus</i>	<i>unicolor</i>	<i>aureicollis</i>	<i>bouvieri</i>	<i>chobauti</i>	<i>humboldti</i>	<i>incrassatus</i>	<i>neglectus</i>	<i>uniformis</i>	
Face with transverse frontal carina	—	—	—	—	—	—	+	+	+	+	—	—	+
Pronotum with lateral carina	—	—	—	—	—	—	—	—	+	+	—	—	—
Malar space longer than 1 MOD	—	—	—	—	—	—	—	+	—	—	—	—	+
Mesopleuron with medial groove	+	+	+	+	+	—	+	+	—	+	—	—	+
Mesopleuron with U-shaped carina	+	+	+	+	+	+	—	—	+	+	+	—	+
Female T-V and S-V annulate (Fig. 10)	+	—	—	?	—	—	+	?	+	+	—	—	—
Female T-V and S-V dentate (Figs. 13, 14)	—	—	+	?	+	—	—	?	—	—	—	—	—
Female T-V and S-V unmodified (Figs. 11, 12)	—	—	—	?	—	—	—	?	—	—	+	—	+
Tongue shorter than eye height	—	—	—	—	?	—	—	—	—	—	—	—	+

Stilbum Spinola

Chrysis, Linnaeus, in part.
Stilbum Spinola 1806:9. Type species: *Chrysis calens* Fabricius, 1781, orig. desig.

Diagnosis.—Face with frontal carina, malar space 2.0 MOD or more long (Fig. 2), tongue about as long as eye height, mesopleuron with strong medial groove and 3 or more teeth or knobs, scutellum elevated, metanotum enlarged into a backward projecting spoon-like structure (Fig. 5), T-I anterior corners rounded, T-III with 4 apical teeth, female T-V and S-V apically pointed with large ridge-like annulations (Fig. 10).

Distribution (Fig. 1).—Southern Europe, Africa, Madagascar, India to the Australasian Region.

Included species (after Linsenmaier, 1959).—*calens* (Fabricius) 1781 (*Chrysis*), *chrysocephalum* Buysson 1897, *cyanurum* Förster 1771, *pici* Buysson 1891, *viride* Guérin 1842.

Discussion.—*Stilbum* includes the largest chrysidids and certainly the most commonly encountered species in Africa, parts of Asia and Australia. The exact number of species in this genus is controversial; unlike Linsenmaier (1959), Zimmermann (1937) considered *Stilbum* to contain only 2 species, *cyanurum* and *viride*, and he synonymized the remainder under *cyanurum*. The question of the number of species in *Stilbum* needs further study. Members of this genus can be distinguished by the unusually long narrow face (Fig. 2), mesopleural sculpture, metanotal projection and T-III with 4 teeth apically. *Stilbum* commonly parasitizes wasps that build mud nests on a variety of surfaces including man-made structures, which may account for the commonness and wide distribution of this genus.

LITERATURE CITED

- Bischoff, H. 1910. Die Chrysididen des königlichen zoologischen Museums zu Berlin. Mitt. Zool. Mus. Berlin 4:427-493.
- Bohart, R. M. 1966. The genus *Neochrysis* in America north of Mexico. Bull. Brooklyn Ent. Soc. 63:139-144.
- Bohart, R. M., and L. S. Kimsey. 1980. A generic synopsis of the Chrysididae of America north of Mexico. J. Kansas Ent. Soc. 53:137-148.
- . 1982. A synopsis of the Chrysididae in America north of Mexico. Mem. Amer. Ent. Inst. 33:1-266.
- Dahlbom, A. G. 1854. Dispositio methodica specierum Hymenopterorum, etc. Berlinianis, Lund, 20 pp.
- Grandi, G. 1961. Studi di un entomologo sugli imenotteri superiori. Boll. Inst. Ent. Univ. Bologna 25:1-659.
- Guérin-Ménéville, F. E. 1842. Description de quelques Chrysidides nouvelles. Rev. Mag. Zool. (1) 5:144-150.
- Kimsey, L. S., and R. M. Bohart. 1981 (1980). A synopsis of the chrysidid genera of neotropical America. Psyche 87:75-91.
- Latreille, P. H. 1809. Genera crustaceorum et insectorum. Vol. 4. A. Koenig, Parisiis et Argentorati, 397 pp.
- Lichtenstein, J. 1876. Note sur le genre *Chrysis*. Petites Nouv. Ent. 2:227.
- Linsenmaier, W. 1951. Die europäischen Chrysididen. Mitt. Schweiz. Ent. Ges. 24:1-110.
- . 1959. Revision der Familie Chrysididae. Mitt. Schweiz. Ent. Ges. 32:1-232.
- . 1968. Revision der Familie Chrysididae. Zweiter Nachtrag. Mitt. Schweiz. Ent. Ges. 41:1-144.
- Mocsáry, A. 1889. Monographia Chrysididarum orbis terrestris universi. Budapest, Academia Scientiarum Hungarica, 643 pp.
- Nurse, C. G. 1904. New species of Indian Hymenoptera. J. Bombay Nat. Hist. Soc. 16:19-26.
- Radoszkowski, O. 1877. Chrysidiformis, Mutillidae and Sphecidae, pp. i-ii, 1-42. In: A. Fedtschenko, Reise in Turkestan, vol. 2 (Zool. Theil), part 5.
- Schulz, W. A. 1906. Spolia Hymenopterologica. A. Pape, Paderborn, 355 pp.
- Semenov, A. 1892. De genere *Pseudochrysis*. Horae Soc. Ent. Rossicae 26:480-491.
- Spinola, M. 1806. Insectorum Liguria species novae aut rariores, etc., Vol. 1. A. Koenig, Parisiis et Argentorati, xvii + 160 pp.
- Zimmermann, H. 1937. Über die Verbreitung und Formenbildung der Gattung *Stilbum*. Arch. Naturges. (Leipzig) 6:645-662.

***Bohartiellus*, a New Genus of Doryctinae from
South America (Hymenoptera: Braconidae)**

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Throughout my undergraduate study in entomology at the University of California, Davis, I was undecided about an area of specialization. During the summer of my senior year I enrolled in the summer field course, Ent. 49, which was required for graduation. That year the six-week course was held at the Southwest Research Station in Portal, Arizona, under the direction of Richard M. Bohart. Those six weeks were a memorable experience and I probably learned more about insects during that short amount of time than during the previous four years. Dick's enthusiasm about insects and his interest in the students made it clear to me that taxonomy was the field I would pursue.

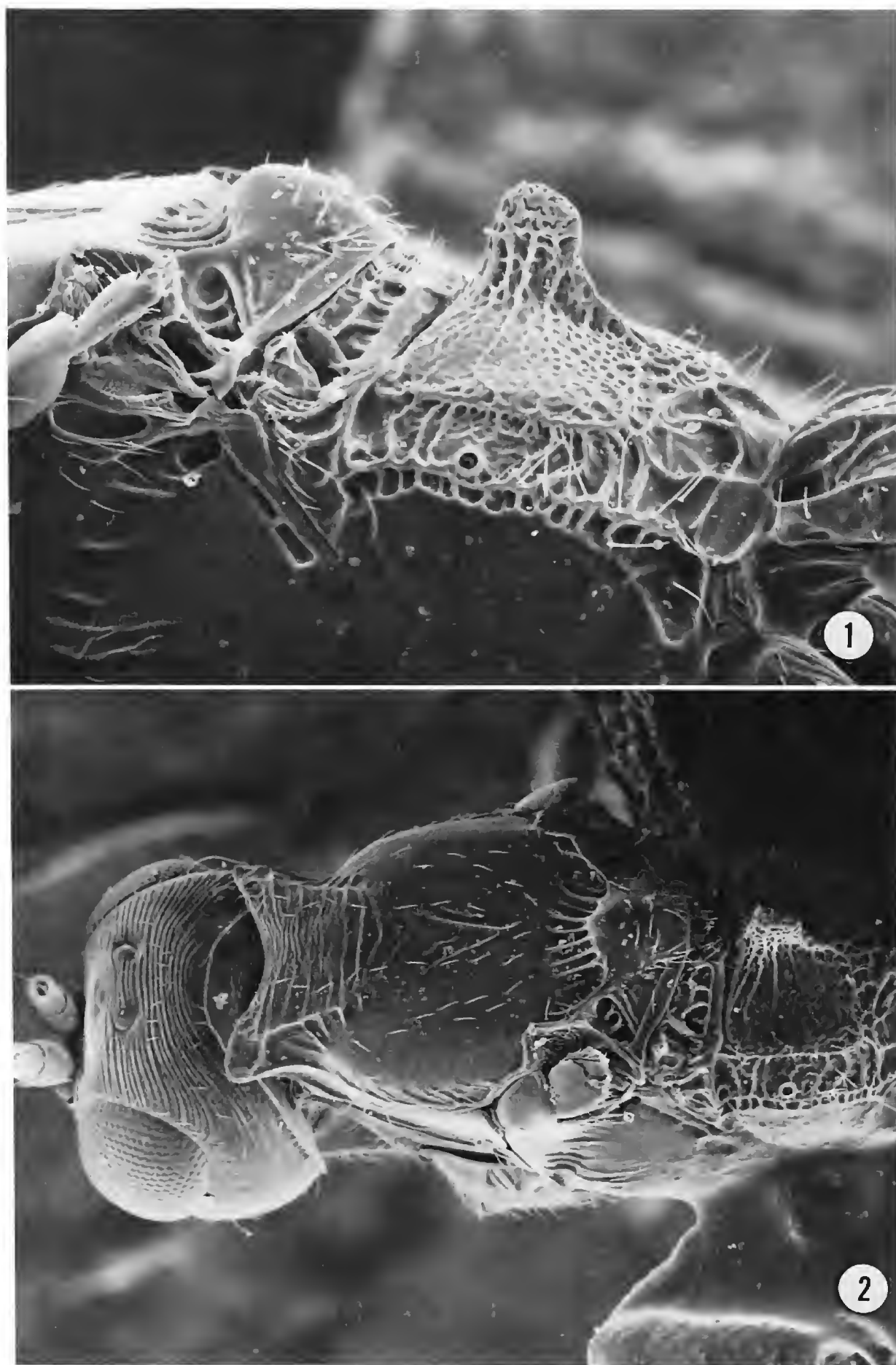
When I began graduate work, the major question became which group of insects to study. Since Dick was my advisor, I expected he would suggest a group of aculeate wasps, his first love. During our first discussion, however, I recall Dick saying to me, "Paul, if I were starting now, I would take up the Braconidae." He must have sensed the emerging concern about the effects of insecticides on the environment and the resulting need to emphasize biological control, at the heart of which is knowledge of natural enemies of insect and mite pests, particularly the parasitic wasps. I took his advice and launched into a thesis research problem on the systematics of Braconidae. Shortly before I completed my Ph.D. degree in 1964, Rachel Carson published "Silent Spring" and biological control took on a new and important meaning. Three days after handing in my thesis, I reported to Washington, D.C., to begin my career as a specialist on the Braconidae for the USDA's Systematic Entomology Laboratory.

I owe an extreme debt of gratitude to "Doc" Bohart for his influence on my career and his training and encouragement during my student days at Davis. To this end I dedicate the remarkable genus of Braconidae described below to a remarkable man.

***Bohartiellus* Marsh, NEW GENUS
(Braconidae: Doryctinae)**

Diagnosis.—Head cuboid, occipital carina present, clypeus semi-circularly emarginate and together with mandibles forming a circular mouth opening; foretibia with row of 6–8 stout spines along anterior edge; propodeum medially at base with a laterally flattened lamella which projects dorsally (Fig. 1); forewing (Fig. 3) with two cubital cells, recurrent vein ending at first cubital cell, nervulus present, first brachial cell closed at apex well before recurrent vein; hindwing (Fig. 3) without nervellus; male abdomen elongated, often more than twice as long as thorax, due to telescoping and extension of segments 4–7.

Type of genus.—*Bohartiellus cornutus* Marsh, new species.



Figs. 1, 2. *Bohartiellus cornutus*. 1, Propodeum, lateral view. 2, Head and thorax, dorsal view.

Etymology.—Named for Richard M. Bohart, mentor and friend.

This genus is similar in wing venation and elongation of the male abdomen to *Aivalykus* Nixon but differs from *Aivalykus* and from all known western hemisphere Doryctinae by the unusual lamella projecting dorsally from the propodeum (Fig. 1). In this regard it is similar to *Spathioplites* Fischer from Chad

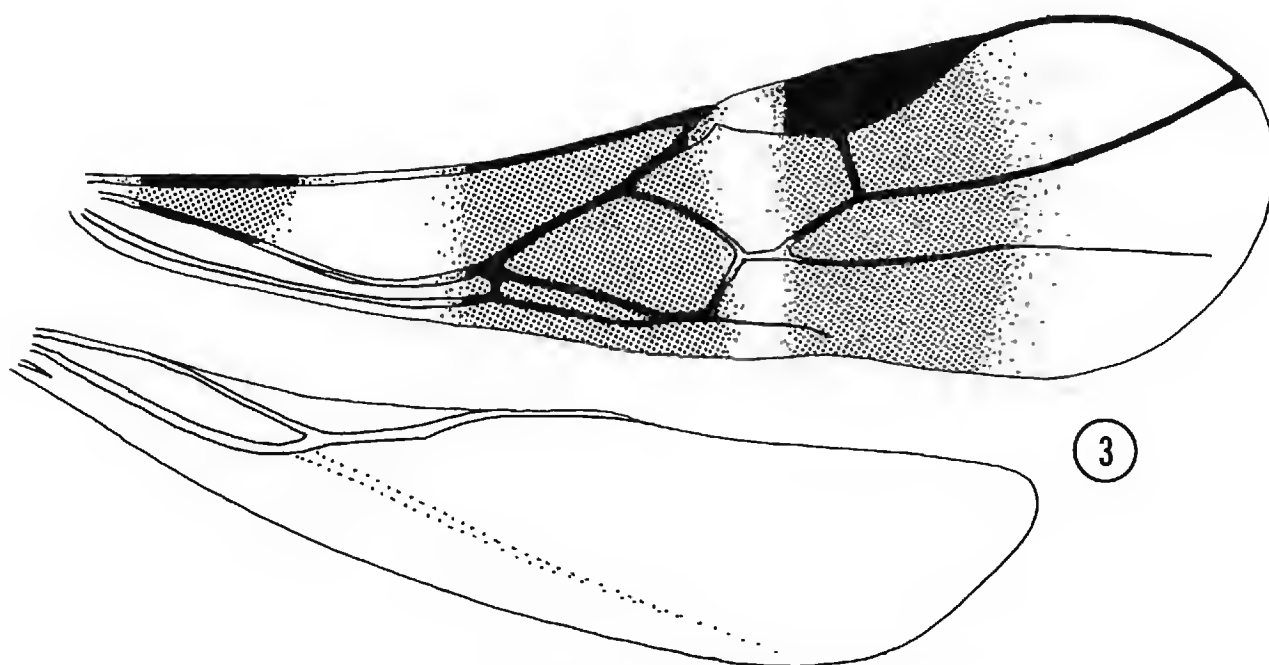


Fig. 3. *Bohartiellus cornutus*, fore and hindwings.

(French Equatorial Africa) but the lamella-like structure of *Spathioplites* arises from the postscutellum rather than from the propodeum as in *Bohartiellus*. Furthermore, *Bohartiellus* has two cubital cells in the forewing whereas *Spathioplites* has three.

***Bohartiellus cornutus* Marsh, NEW SPECIES**
(Figs. 1–3)

Female.—Length of body, 2.5–3.0 mm; ovipositor, 2.0–2.5 mm. Color: head dark honey yellow; antenna honey yellow, apical 3–4 flagellomeres brown; thorax and abdomen dark brown, median mesonotal lobe light brown anteriorly; legs brown, fore tarsus yellow, hind tibia yellow at base; forewings banded (Fig. 3). Head: vertex (Fig. 2) and frons strigate¹, temples smooth, face strigate-rugose with median raised smooth area; malar space about $\frac{1}{3}$ eye height; ocell-ocular distance about 3 times diameter of lateral ocellus; antenna 17-segmented (broken in holotype). Thorax: median mesonotal lobe strigate-rugose, anterior corners produced into large horn-like structures (Fig. 2), lateral mesonotal lobes smooth; notauli not distinct, indicated only by carinate lines; scutellar furrow with 6–8 cross carinae; scutellum swollen, smooth; mesopleuron smooth, subalar groove weakly scrobiculate; sternaulus absent; propodeum strigate-rugose dorsally, the strigae emanating from median raised lamella, propodeum smooth laterally. Abdomen: first tergum about 2.5 times as long as wide at apex, strigate-rugose; rest of terga smooth and polished; ovipositor as long as abdomen and thorax combined.

Male.—Essentially as in female except for sexual differences.

Types.—Holotype ♀: BOLIVIA: Cavinass, Rio Beni, Wm. M. Mann, Feb. 1922, deposited in the National Museum of Natural History (USNM). Paratypes: 1 ♀, same data as holotype; 1 ♀, 2 ♂♂, BRASIL: Rio Caraguala, 21°48' B., 52°27' L., Fritz Plaumann, April 5–7, 1953, deposited in the USNM and the Canadian National Collection, Ottawa (CNC).

¹ All terms for sculpturing are based on Harris, 1979.

This species differs from *Bohartiellus plaumanni*, new species, by the large horn-like anterior corners of the mesonotum, the shorter malar space which is $\frac{1}{3}$ the eye height, the swollen scutellum, and the smooth mesopleuron.

The specific name is from the Latin *cornutus* which means horned in reference to the horn-like projections on the anterior corners of the mesonotum.

***Bohartiellus plaumanni* Marsh, NEW SPECIES**

Female.—Length of body, 2.5 mm; ovipositor, 2.0 mm. Color: entire body and legs brown except basal antennal segments and all tarsi which are honey yellow; forewing banded as in *cornutus*. Head: vertex and frons strigate, temples smooth, face strigate-rugose with median raised smooth area; malar space about $\frac{1}{2}$ eye height; ocell-ocular distance about 3 times diameter of lateral ocellus; antenna 17-segmented. Thorax: mesonotal lobes coriaceous, anterior corners of mesonotum without large horn-like projections as in *cornutus*; notauli distinct and strongly scrobiculate; scutellar furrow with 6-8 cross carinae; scutellum flat, smooth; mesopleuron strigate, subalar groove weakly scrobiculate; sternaulus absent; propodeum strigate-rugose dorsally, the strigae emanating from the median lamella, propodeum smooth laterally. Abdomen: first tergum about 1.5 times as long as wide at apex, strigate-rugose; rest of terga smooth and polished; ovipositor as long as abdomen and thorax combined.

Male.—Essentially as in female except for sexual differences.

Types.—Holotype ♀: BRASIL: Rondon, 24°38' B., 54°07' L., Fritz Plaumann, VIII-1952, deposited in the CNC. Paratypes: 1 ♀, 2 ♂♂, same data as holotype, deposited in USNM and CNC.

This species differs from *Bohartiellus cornutus* by the reduced anterior corners of the mesonotum, the longer malar space which is $\frac{1}{2}$ the eye height, the flat scutellum, and the strigate mesopleuron.

This species is named after its collector Fritz Plaumann.

LITERATURE CITED

- Harris, R. A. 1979. A glossary of surface sculpturing. Calif. Dept. Food Agric., Ent. Occas. Pap. No. 28, 31 pp.

**Biology of a New *Trypoxylon* that Utilizes Nests of
Microstigmus in Costa Rica
(Hymenoptera: Sphecidae)**

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In the Neotropics, spider-hunting wasps of the genus *Trypoxylon* are extraordinarily diverse (Bohart and Menke, 1976). The subject of this report was first noted in 1968 (Matthews, 1968:37), but no adults were collected until 1980. Professor O. W. Richards and Dr. Arnold S. Menke kindly examined the wasp, declared it to be a new species, and very graciously offered to describe it. My notes on nesting biology follow the species description.

***Trypoxylon latro* Menke & Richards, NEW SPECIES
(Figs. 1-13)**

Holotype male.—Color: Black. Scape, pedicel pale brown above, whitish yellow below; clypeal margin, labrum and mandible pale brown; palpi, pronotal lobe, precoxal lobes, coxae apically, trochanters and foretarsus pale yellow; forefemur brownish above, brownish yellow below; midfemur brownish; fore and midtibiae brownish yellow; midtibial spur and basal half of tarsomere I pale yellow, rest of midtarsus brownish; basal third of hindtibia and spurs pale yellow; hindtarsus brownish.

Vestiture: Clypeus and lower frons, including eye emarginations, with dense appressed silver setae; gena, pronotal collar, scutum laterally, metanotum laterally, mesopleuron, propodeal dorsum and hindface with sparser, suberect silver setae; rest of body covered with fine, pale setae except metapleuron and propodeal side glabrous.

Structure: Flagellomere VIII abruptly expanded apically in profile, IX-XI of same width (Fig. 13); flagellomeres III-IV and VII-VIII with narrow polished tyli (those on III-IV very difficult to detect even at 75 $\times$); flagellomere IV flattened and with small apical tooth-like process; comparative lengths of flagellomeres I-II and XI: 7:5.5:17; greatest length of flagellomere XI slightly more than combined lengths of VIII-X; frontal carina evanescent, represented by short, polished line above transverse supra-antennal carina; frons minutely granulate, dull, shallowly punctate, punctures separated by about two diameters; least interocular distance at vertex nearly twice that at clypeus (21:12); ratio of ocellocular distance to hindocellus diameter to distance between hindocelli: 2:6:4.5; clypeal free margin as in Fig. 2, edge thickened at middle third as seen from below; labrum consisting of two narrow, fingerlike lobes; occipital carina a complete circle, separated from hypostomal carina by slightly less than a hindocellus diameter (4.5:6); scutal and scutellar sculpture and punctation similar to frons but weakly shining; propodeal dorsum with pair of shallow, arcuate furrows which are evanescent posterad, resulting enclosure with broad, shallow, median longitudinal depression which is cross carinulate, carinae strongest and converging at base of enclosure; propodeal

side highly polished, impunctate except for zone of dense setae posteriorly above hindcoxa, side delimited dorsad by arcuate shelf-like ridge, dorsal rim of petiole socket without a backward projecting lamella; posterolateral corner of propleuron with roughly egg-shaped platelike area which is delimited inwardly by a carina; mesopleuron finely, shallowly punctate, depression around scrobe about equal to hindocellus diameter; metapleuron highly polished, impunctate except above hindcoxa; metapleural flange lamellate, its margin translucent, not down curved; intercoxal carina slightly arcuate; dorsal carina of hindcoxa not reaching coxal apex; gaster claviform, segment I gradually expanding toward II, I not quite twice as long as wide (46:28) in dorsal view; sternum VIII as in Fig. 8; genitalia as in Fig. 11, aedeagal shaft arcuate in lateral profile, penis valve head with sharp lateral process.

Length: 6 mm.

Female.—Color: As in male except scape yellow brown, pedicel brown above, yellow brown beneath; foreleg whitish yellow except upper surface of femur with brownish stripe and coxa yellowish brown; midfemur brownish but with pale yellow area at base; midtibia pale yellow behind, basal fourth of gastral segments II–III ringed by pale yellow.

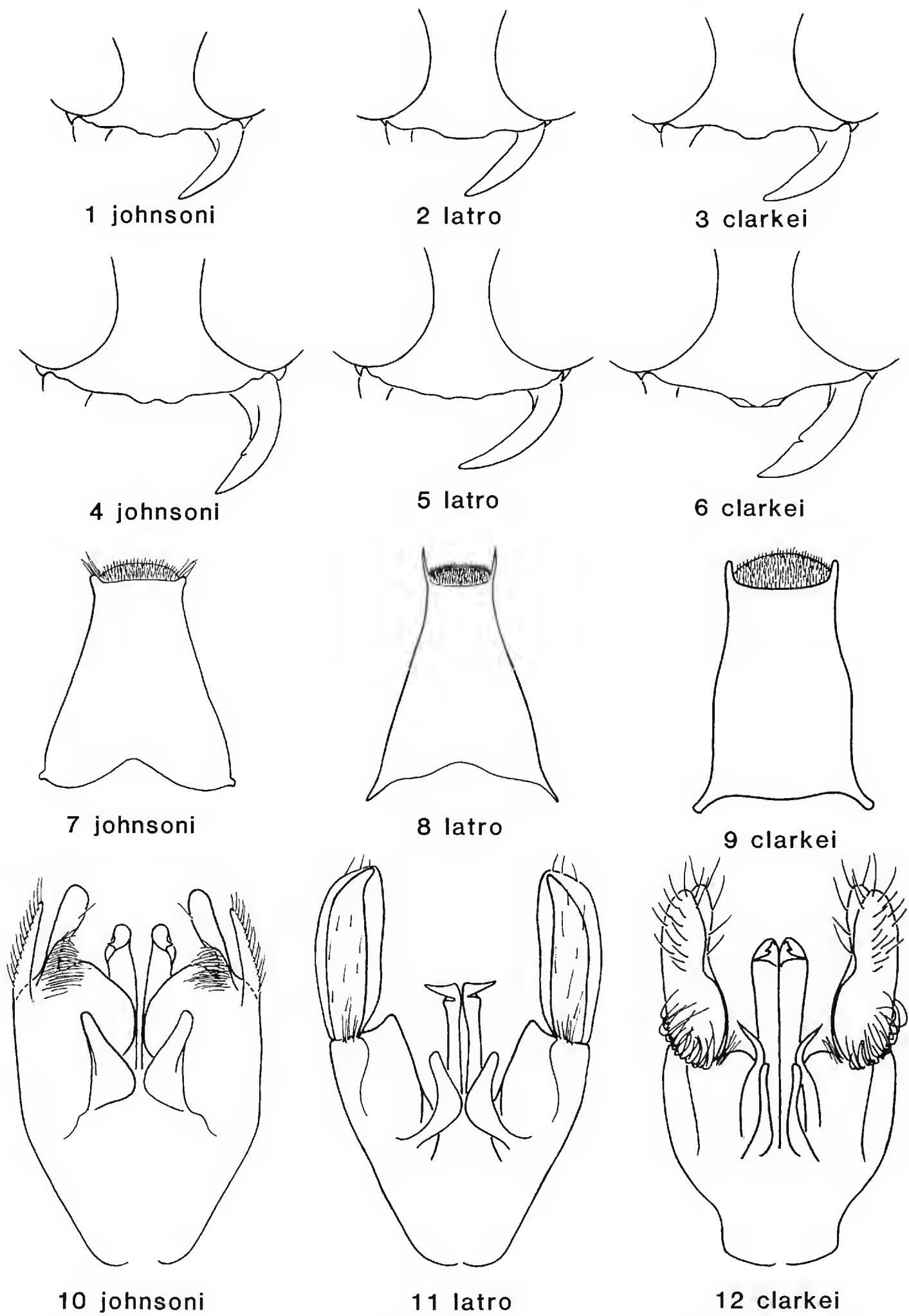
Vestiture: Same as male.

Structure: As in male except: flagellum simple, comparative lengths of flagellomeres I–II and X: 13.5:11:15.5; flagellomere X length equal to combined lengths of VIII–IX; least interocular distance at vertex more than twice that at clypeus: 23.5:10.5; ratio of ocellocular distance to hindocellus diameter to distance between hindocelli: 1.5:7.5; clypeal margin less sinuate than male (Fig. 5); inner margin of mandible simple as in male (Fig. 5); length of tergum I a little less than twice width (range: 58:35–55:32).

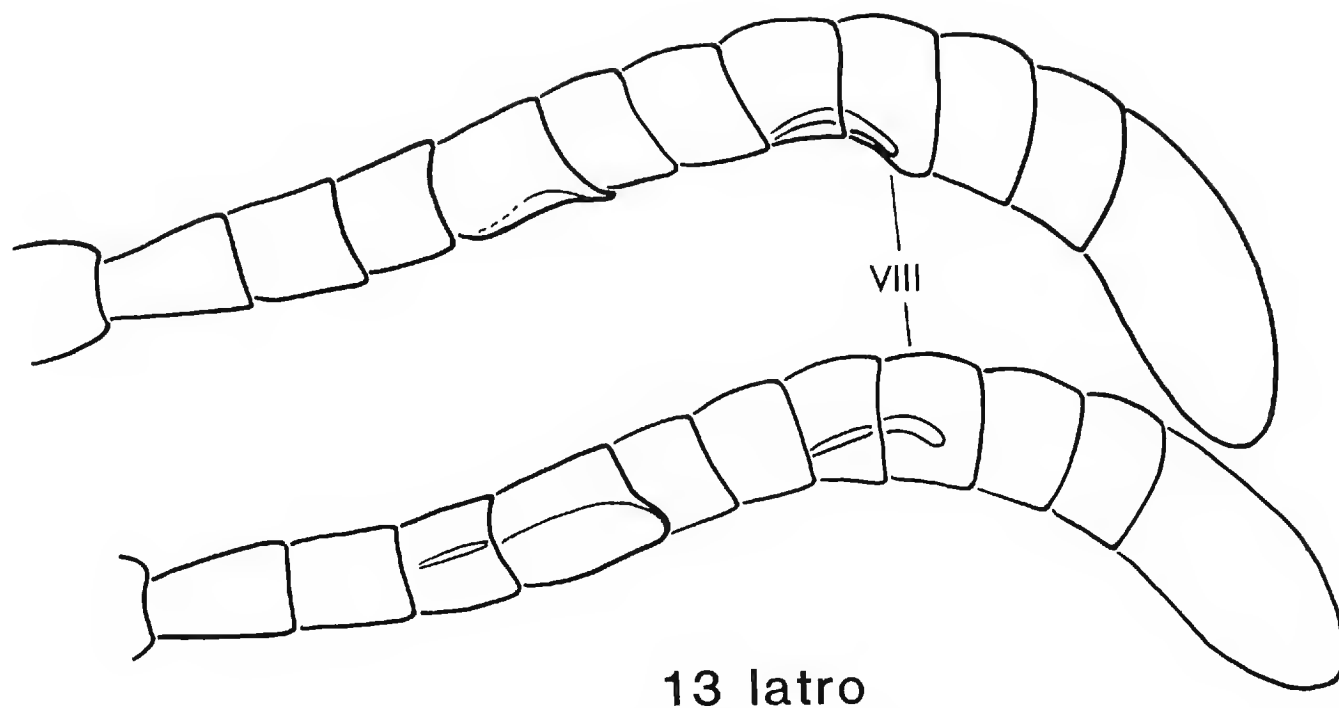
Length: 6–6.5 mm.

Discussion.—The clavate gaster of *T. latro* is suggestive of the monotypic genus *Pisoxylon* Menke (1968), and both have a bilobed labrum and somewhat similar male antennae. But *Pisoxylon* has a much more compact gaster, the occipital carina runs into the hypostomal carina, the propodeal side curves to the dorsum without interruption, the metapleural flange is not lamellate, the hindcoxa has only a suggestion of a dorsal carina, sternum VIII is roundly acuminate, the gonostyle is not bilobate and the penis valve lacks spines or other processes. In *T. latro* the occipital carina is a complete circle which is separated from the hypostomal carina, the propodeal side is highly polished, glabrous, and sharply delimited dorsally by a shelf-like ridge, the metapleural flange is broadly lamellate, the hindcoxal carina is strongly indicated, male sternum VIII is truncate apically and bispinose, the gonostyle is bilobed and the penis valve is adorned with spinose processes. These characters negate a close relationship with *P. xanthosoma*, and they indicate that *T. latro* belongs in the *fabricator* group (see Bohart and Menke, 1976:344, and Richards, 1934:280) of *Trypoxylon*. In fact, *latro* is very similar to the North American species *T. johnsoni* Fox and *T. clarkei* Krombein as demonstrated by the labrum, the male antenna, sternum VIII, the male genitalia and the general habitus.

T. latro differs from *johnsoni* in the following ways: In both species the propodeal side just above the hindcoxa is densely covered by setae which rather sharply delimit this zone from the remainder of the side. In *johnsoni* a ridge



Figs. 1-12. Details of *Trypoxylon* species. 1-3, male clypeus and mandible. 4-6, female clypeus and mandible. 7-9, male sternum VIII. 10-12, ventral view of male genitalia.



13 latro

Fig. 13. Two views of left male flagellum of *Trypoxylon latro*.

extends dorsad from the hindcoxal articulation partially delimiting this setal zone. This ridge is usually paralleled anterad by several shorter ridges. The least interocular distance is comparatively shorter in females of *latro*. When the interocular distance at the vertex is compared to that at the clypeus and the length of flagellomere I the resulting ratios are obtained: *latro*: 23.5:10.5:13.5, *johnsoni*: 26:18:16. The female clypeus of *latro* (Fig. 5) lacks the two prominent, rounded lobes (Fig. 4) found in *johnsoni*. The inner margin of the female mandible is simple in *latro* (Fig. 5), but there is a weak tooth in *johnsoni* (Fig. 4). In both sexes of *latro* the hindocelli are separated by less than an ocellus diameter (5:7.5), while in *johnsoni* they are separated by an ocellus diameter or more (7:7). The male antennae are quite similar in the two species, but flagellomere VIII of *johnsoni* lacks a tyloid. Furthermore, flagellomere IV in *johnsoni* has a semicircular depression which accentuates the apical toothlike process. Tergum I in *latro* is about twice as long as wide or slightly less in the female, while in *johnsoni* it is almost three times as long as wide. In the male of *latro* I is less than twice as long as wide, while in *johnsoni* it is slightly more than twice as long as wide. The male genitalia are very different (compare Figs. 10, 11). In *latro* the gonostyle ends in two elongate, broad flat lobes which overlay each other dorsoventrally (Fig. 11). In *johnsoni* the gonostyle ends in two narrow lobes which lie side by side, the outermost being narrower and attenuate apically (Fig. 10).

T. latro is immediately separable from *clarkei* by the complete occipital carina. In *clarkei* the carina is incomplete below, although the gap between the ends is narrow in some males. The propodeal side of *clarkei* is less densely setose posteriorly above the hindcoxa than in *latro*, and the shelf-like dorsal ridge is weaker, but these are features that require specimens of both species to appreciate. The intercoxal carina is straight in *clarkei*, arcuate in *latro*. In the female of *clarkei* the least interocular distance at the vertex is about twice that at the clypeus, the distance at the latter equalling the length of flagellomere I (29:14:14). In *latro* the ratios are 23.5:10.5:13.5. The female clypeus of *clarkei* is produced into a truncate

lobe, and there is a weak tooth on the inner margin of the mandible (Fig. 6). In both sexes of *clarkei* the ocellocular distance is equal to half (female) or two-thirds (male) a hindocellus diameter. In both sexes of *latro* the ocellocular distance is less than half a hindocellus diameter. As in *latro*, the apical lobes of the gonostyle of *clarkei* are broad and overlay each other, but ventrally there is a dense "basket" of long curved setae at their base (Fig. 12, also illustrated by Sandhouse, 1940: Fig. 48—misidentified as *johnsoni*). The gonostyle of *latro* lacks the basal "basket" and is sparsely setose in general (Fig. 11).

Etymology.—*Latro* is a Latin noun meaning robber which refers to the habit of using nests of *Microstigmus* for its own.

Types.—Holotype ♂: COSTA RICA, Puntarenas Prov., Corcovado Natl. Park, Sirena Station, nest 71, March 8, 1981, R. W. Matthews (USNM type #100374). Paratypes: 4 ♂, 10 ♀, same place as type, various dates in February and March 1981, and Oct. 1980, all R. W. Matthews or Matthews and C. K. Starr, deposited in U.S. National Museum, British Museum (Natural History), Univ. of Georgia, Univ. of Costa Rica, and Univ. of Sao Paulo.

BIOLOGICAL NOTES

Study method.—This study was conducted between October 1980 and September 1982 at Sirena, in Corcovado National Park on the Osa Peninsula, Guanacaste Province, Costa Rica. In the primary forests along the Ollas Trail, the eusocial sphecoid wasp *Microstigmus comes* nests abundantly on the palm *Cryosophila guagara*. Monthly censuses of all *M. comes* nests in the study site were taken, so that complete records of individual nest histories were obtained for over 700 nests, many of which were appropriated by *T. latro* (Fig. 14). *Trypoxylon latro* nests were collected during 4 extended visits to the study site. Dissections of these nests, rearings, and incidental observations produced the information reported here.

Nest architecture.—*Trypoxylon latro* utilizes only the empty upper portion or "attic" of the *M. comes* nest. There appears to be no modification of existing *M. comes* cells or the nest entrance other than the application of irregular splotches of mud to the floor and sides of the nest interior. I could find no trace of old *M. comes* cells or their contents. Petioles of nests appropriated by *Trypoxylon* often lose their distinctive tight coil and become "wavy" (Fig. 14), a useful field cue. Presumably this loss of coil tightness reflects a lack of the maintenance normally given by *Microstigmus* adults, rather than modification by *T. latro* females.

Dissections of 86 nests from 4 collections are summarized in Table 1. Nests contained an average of 1.3 cells (range 1–3). There was a marked seasonal difference in the average nest size. Nests constructed in the wet season (August–October) averaged 1.19 cells ($n = 57$), whereas those constructed in the dry season (February–March) were larger, averaging 1.62 cells ($n = 21$). This difference is highly significant (Mann-Whitney Test, $z = 3.56$, $P < 0.0002$). Similarly, the number of nests with 2 cells was significantly greater in the dry season ($\chi^2 = 9.64$, $P < 0.01$). When 2 cells were constructed, a weak mud partition of about 0.5 mm thickness separated the lower (first-made) cell from the upper one. Due to the pear-like shape of an *M. comes* nest, the upper cell was invariably smaller in size and volume. In the single nest with 3 cells, the lower space was partitioned in half. Empty "vestibule" cells between the upper cell and the sealed nest entrance



Fig. 14. A *Trypoxylon latro* female carrying prey into the entrance of a *Microstigmus comes* nest. Constructed of the waxy pubescence found on the underside of *Crysophila guagara* palms and bound together with silk, the nest now lacks the strong petiole coil characteristic of an active *Microstigmus* colony (cf. Fig. 4 in Matthews, 1968). The petiole is about 14 mm long.

occurred in 7% of all nests, all from the wet season. Four nests had a final closure but were entirely empty.

Life history.—The egg, about 1.2 mm long and 0.4 mm wide, was attached obliquely to the anterior lateral surface of the spider's abdomen. Two eggs observed in the laboratory hatched within 3 days of collection.

Larval growth was rapid. In the single case observed, a newly hatched larva completed its full growth and constructed a cocoon in 4 days. Such rapid devel-

Table 1. Contents of 86 *Trypoxylon latro* nests from 4 collections (1 dry season, 3 wet seasons) taken at Sirena, Corcovado National Park, Costa Rica.

Collection date	Nests in sample	Nests without cells		Nests with cells								
		Mud-lined only	Empty but with final closure	Total cells/nest			Vestibule cell present	Provisioning		Egg	Cocoon	
				1	2	3		Incomplete	Scavenged		Un-emerged	Emerged
October 1980	23	0	1	13	8	1	3	1	8	2	5	12
Feb.-March 1981	24	2	1	8	13	0	0	1	0	0	20	14
September 1981	7	0	0	6	1	0	0	0	2	2	1	3
August 1982	32	2	2	25	3	0	3	0	10 ¹	3	8	7

¹ Three individuals of an unidentified chloropid fly were reared from 2 nests.

opment may explain the absence of nests with larvae among those summarized in Table 1.

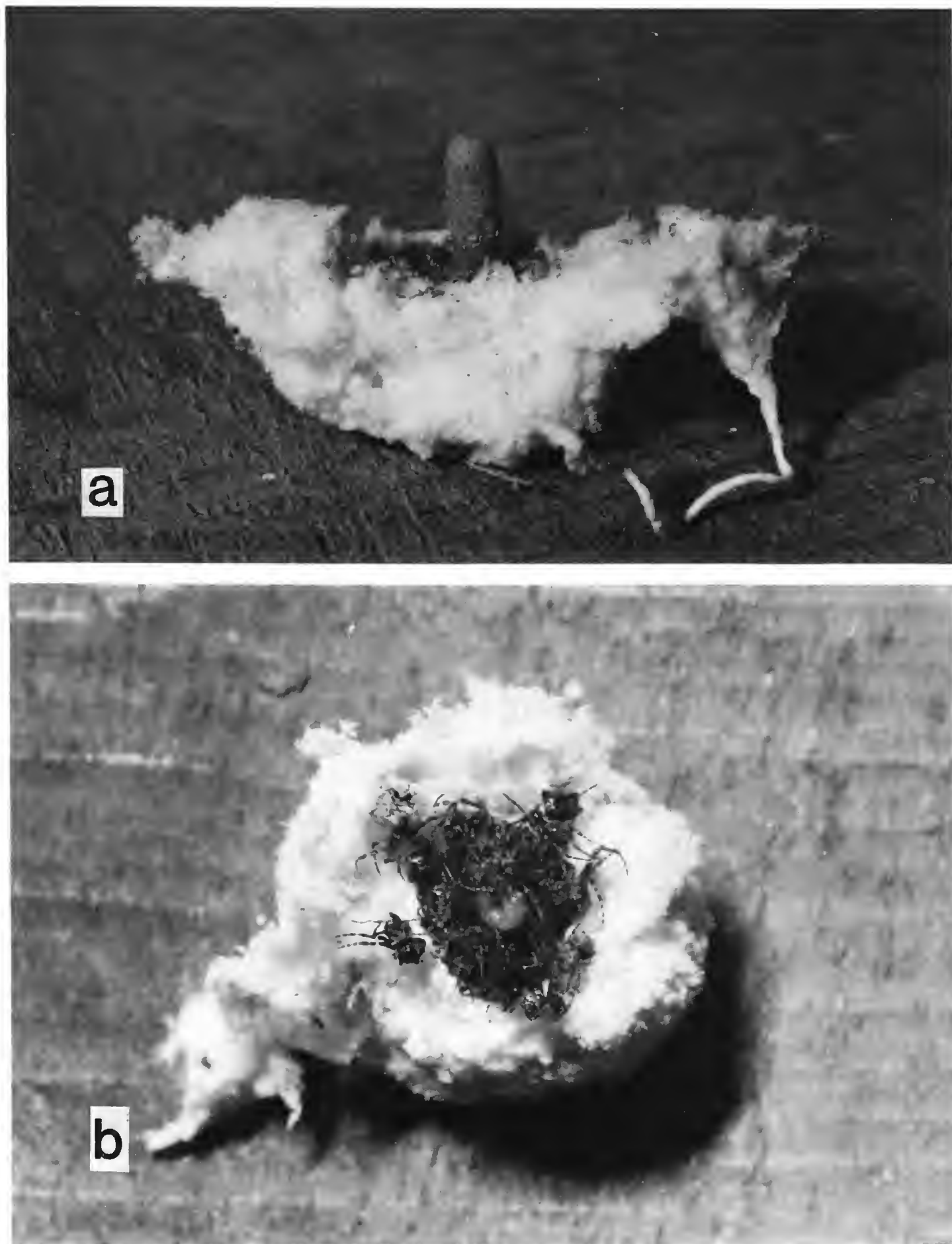
Rounded at both ends, cocoons were attached basally to a bit of the mud in the cell bottom and stood upright or obliquely in the cell (Fig. 15A). Dull gray and of a grainy and brittle texture, cocoons measured an average of 6.8 mm long (range 5.3–7.5, *n* = 20) and 2.1 mm wide (range 1.8–2.3, *n* = 20). Four female cocoons averaged 7.0 mm long (range 6.3–7.5) and a single male cocoon was 6.5 mm long. Overall, cocoons from nests with 2 cells averaged slightly smaller than those from single-celled nests, for those from the upper cells were all at the small end of the size range.

Duration of the pupal stage could not be precisely documented, but eclosions from collected nests continued over a period of at least 2 months. No diapause or quiescent stage was detected.

Overall the sex ratio of the reared adults was 18 females to 8 males. However, emergences from the 14 single-celled nests were strongly female-biased (11 females : 3 males). Five of the 6 two-celled nests from which both adults emerged yielded one of each sex. Presumably the males came from the smaller cocoons of the upper cells. Upon emergence, adults characteristically chewed directly through the side wall of the nest bag rather than through the mud closure plug.

Prey.—Cells were mass provisioned with spiders (Fig. 15B). A sample of 133 spiders from 8 cells was preserved. The number of prey per cell averaged 16.6 (range 9–28). Dr. H. W. Levi of the Museum of Comparative Zoology, Harvard University, identified them as *Leucauge* and *Dolichognatha* in the Tetragnathidae. *Leucauge* was uncommon in the sample, with only 6 juveniles represented. However, at least 2 species of *Dolichognatha* were represented. Nearly half (48%) of the individuals were juveniles, 13.7% were males, and 38.3% were females. According to Dr. Levi, *Dolichognatha* constructs small orb webs at the base of trees. Neotropical tetragnathids are largely unstudied, but recent revisions of Nearctic genera are available (Levi, 1980, 1981).

Natural enemies.—As shown in Table 1, nest cells attacked by scavenger fly larvae were found in all 3 wet season collections but not in the dry season collection. In the wet season 12.5–32.1% of total cells were infested. In August 1982, 3 unidentified chloropid fly adults were successfully reared from scavenged prey



Figs. 15A, B. A, cocoon of *T. latro* attached by its posterior end to a spot of mud in the bottom of the nest. Cocoon is 7.0 mm long. B, *Dolichognatha* spider prey and small larva of *T. latro* in an *M. comes* nest.

in 2 nests. An unidentified ichneumonid wasp was reported as emerging from a cocoon in a mud-plugged nest in 1968 from a different locality (Matthews, 1968), but none were taken in the present study.

Adult behavior.—On 7 March 1981, a female was observed carrying prey into

an *M. comes* nest in which, 6 days earlier, a single *M. comes* female had been present. The nest was less than 4 weeks old according to census records. Whether *T. latro* usurped the nest or took over after it had become abandoned is undetermined, but the evidence suggests that the nest may have been usurped.

Provisioning was first noted at 1110 AM CST when the female *T. latro* was seen to enter with prey. During the next 116 minutes she brought in 10 additional spiders. Time away from the nest ranged 3–42 minutes ($n = 10$), whereas the time inside the nest to store the prey was always brief, ranging 5–18 seconds. After a lapse of 81 minutes I returned to the nest at 1645 PM. The female returned with a spider at 1647, and remained inside for 49 seconds before departing. Presumably oviposition occurred at this time, for 2 minutes later she returned carrying mud, then made 5 more trips for mud in rapid succession, each requiring less than 1 minute. All of this mud was applied inside the nest, with the wasp spending 46–70 seconds each time at this task. During these periods of mud application I was unable to detect any audible buzz like that produced by the subgenus *Trypargilum* during mud application. Presumably the wasp was closing off the lower cell at this time.

Impact on host population.—At my study site, monthly census of the status of all *M. comes* nests from February, 1981 to May, 1982 revealed that *T. latro* utilized a relatively small but more or less constant proportion of about 5% of the potentially available nests. The average number that became *Trypoxylon* nests each month was 9.8 (range 5–21) of an average of 187 active *M. comes* nests.

Two other Sirena samples of nests from outside of the census area gave comparable rates of *T. latro* nest utilization. The first involved 64 *M. comes* nests collected at night on 8 March 1981 (dry season). Five (7.8%) proved to be occupied by *Trypoxylon*. A second night-collected sample, made on 4 September 1982 (wet season), involved 65 nests, of which 6 (9.2%) were *Trypoxylon*. Of these, 4 were in nests known to be constructed by *M. comes* more than 3 months earlier, and 2 were in nests constructed within the past 3 months. According to the nest census records from the study site, nests of all ages are vulnerable to appropriation by *T. latro*. No preference for nests of a particular age could be detected. Overall, activity of *T. latro* accounted for 24% of the total *M. comes* mortality in the study site.

Discussion.—*Trypoxylon* is a huge genus with over 450 species and a great diversity of behavior. It includes two subgenera, *Trypoxylon* and *Trypargilum*. The revision of the American *Trypoxylon* by Richards (1934) remains the definitive study of the genus in the New World. Coville's (1982) revision of the subgenus *Trypargilum* in North America is a recent contribution to the taxonomy of that group. The widespread use of preformed cavities for nesting, including the abandoned cells of other wasps, has allowed researchers to use the trap-nest technique (Coville and Coville, 1980; Coville, 1981; Coville and Griswold, in prep.) to expand our knowledge of Neotropical *Trypargilum*. Species of the subgenus *Trypoxylon* are less well known, and probably many undescribed species exist. Many also take trap-nests and at least 2 species, *T. johnsoni* and *T. clarkei*, characteristically nest in preexisting cavities (Krombein, 1967). However, members of the *fabricator* group, to which *T. latro*, *johnsoni*, and *clarkei* belong, typically construct free mud nests.

The use of *Microstigmus* nests by *T. latro* is unique. Building a mud nest within

the small, flexible silk-lined nest sacs of these primitively social wasps would seem rather analogous to building a house inside a laundry bag. Moreover, abandoned nest sacs are rather delicate and rarely persist for long before the petiole breaks or becomes detached from the plant leaf.

In the Neotropics, insects, particularly ants, compete intensely for cavities suitable for nesting. Ants have exploited a great variety of seemingly unlikely cavities, from hollow thorns to galls. Virtually every hollow twig that one breaks open is occupied by ants. The vast majority of trap-nests that I have placed in the field in various localities in Costa Rica have been quickly exploited by ants. However, of over 700 *Microstigmus* nests monitored over a 16 month period, only one was found to be occupied by an ant colony (a species of *Tapinoma*). Thus, *Microstigmus* nest bags are apparently either being overlooked by searching ants or are in some manner unacceptable to them. By exploiting this unusual habitat, *T. latro* minimizes competition from ants. Furthermore, since no parasites were reared from any nests in this study, *T. latro* also appears to be avoiding certain other sources of mortality, such as chrysidid wasps, that regularly parasitize related species nesting in more "typical" habitats.

Yet despite the abundance of potential nest sites, *T. latro* is a relatively rare species. Due to the small size of the *Microstigmus* nest bag, nests rarely contain more than 2 cells. While *T. latro* nests continuously throughout the year, it clearly is more successful during the dry season. Dry season nests contained significantly more cells and suffered no losses to scavenger flies. These differences probably reflect differences in prey abundance, humidity, and available time for nesting.

Trypoxylon latro is unusual in that its brittle grainy cocoons are unlike "typical" *Trypoxylon* cocoons, which are papery and tan-colored. However, at least one other *Trypoxylon* species, *T. johnsoni*, constructs a similar cocoon and also nests in preformed cavities (Krombein, 1967). As Menke and Richards note in their description, *T. latro* is closely related to *T. johnsoni* morphologically. Dr. Krombein kindly loaned me cocoons of *T. johnsoni* for comparison and they are virtually identical to those of *T. latro*, which is additional evidence for the close relationship of these 2 species.

ACKNOWLEDGMENTS

It is a pleasure to dedicate this paper to Dr. Richard M. Bohart, whose contributions to our knowledge of wasps have been truly monumental. I thank Dr. Rollin E. Coville for initially determining that *T. latro* was undescribed and Prof. O. W. Richards and Dr. Arnold Menke for describing it. Dr. K. V. Krombein kindly loaned cocoons of *T. johnsoni* for comparison. Dr. H. W. Levi determined the spider prey; voucher specimens are deposited in the Museum of Comparative Zoology, Harvard University. Dr. Christopher K. Starr, now at Visayas State Agricultural College in Baybay, Leyte, Philippines, assisted in data collection. I thank Servicio de Parques Nacionales, San Jose, Costa Rica for permission to work in Corcovado Park. This work was supported by NSF grant BMS7925708.

LITERATURE CITED

- Bohart, R. M., and A. S. Menke. 1976. Sphecid wasps of the world. Univ. Calif. Press, Berkeley, ix + 695 pp.
- Coville, R. E. 1981. Biological observations on three *Trypoxylon* wasps in the subgenus *Trypargilum*

- from Costa Rica: *T. nitidum schulthessi*, *T. saussurei*, and *T. lactitarse* (Hymenoptera: Sphecidae). Pan-Pac. Ent. 57:332-340.
- . 1982. Wasps of the genus *Trypoxylon* subgenus *Trypargilum* in North America (Hymenoptera: Sphecidae). Univ. Calif. Pub. Ent. 97:1-147.
- Coville, R. E., and P. L. Coville. 1980. Nesting biology and male behavior of *Trypoxylon* (*Trypargilum*) *tenocitlan* in Costa Rica (Hymenoptera: Sphecidae). Ann. Ent. Soc. Amer. 73:110-119.
- Krombein, K. V. 1967. Trap-nesting wasps and bees: life histories, nests and associates. Smithsonian Press, Washington, D.C., 570 pp.
- Levi, H. W. 1980. The orb-weaver genus *Mecynogea*, the subfamily Metinae and the genera *Pachygnatha*, *Glenognatha* and *Azilia* of the subfamily Tetragnathinae North of Mexico (Araneae: Araneidae). Bull. Mus. Comp. Zool. 149:1-74.
- . 1981. The American orb-weaver genera *Dolichognatha* and *Tetragnatha* north of Mexico (Araneae: Araneidae, Tetragnathinae). Bull. Mus. Comp. Zool. 149:271-318.
- Matthews, R. W. 1968. Nesting biology of the social wasp *Microstigmus comes* (Hymenoptera: Sphecidae, Pemphredoninae). Psyche 75:23-45.
- Menke, A. S. 1968. New genera and species of wasps of the tribe Trypoxylonini from the Neotropical region (Hymenoptera: Sphecidae, Larrinae). Contrib. Sci. Los Angeles Co. Mus. (135):1-9.
- Richards, O. W. 1934. The American species of *Trypoxylon*. Trans. R. Ent. Soc. Lond. 82:173-362.
- Sandhouse, G. A. 1940. A review of the Nearctic wasps of the genus *Trypoxylon* (Hymenoptera: Sphecidae). Amer. Mid. Nat. 24:133-176.

A Review of the Genus *Polemistus* in the New World (Hymenoptera: Sphecidae)

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Dick Bohart has had a life long love of wasps. While most of us choose other pursuits in our free time, Dick's devotion to his wasps is so intense that they have assumed the status of a hobby with him—he works on them day and night! Few people achieve the broad knowledge and experience in different families of insects possessed by Dick. His work has spanned many aculeate families, and his influence will be felt for many generations to come. The Sphecidae has been one of his favorite groups, and he has published more comprehensive works on this family than any other. We take great pleasure in dedicating our short treatise on *Polemistus* to him.

The cosmopolitan genus *Polemistus* contains 19 described species (Bohart and Menke, 1976). Two of these are poorly known Neotropical species, one of which, the Mexican *pusillus*, was incorrectly reported by Bohart and Menke to occur in the southwestern United States. Our studies of approximately 100 specimens of *Polemistus* from the New World indicate that three species occur in the United States, all of which are undescribed. The three North American species are newly described here, as is a fourth new species discovered in Central America. A key to the six known New World species is provided. Each of us has assumed sole authorship of two of the new species.

Material for this study was borrowed from the following institutions:

Academy of Natural Sciences, Philadelphia (ANSP).
American Entomological Institute, Ann Arbor.
American Museum of Natural History, New York (AMNH).
British Museum (Natural History), London (BMNH).
California Academy of Sciences, San Francisco (CAS).
Cornell University, Ithaca (CUI).
Museum d'Histoire Naturelle, Geneva (Geneva).
National Museum of Natural History, Washington DC (USNM).
Naturhistorisches Museum, Vienna (Vienna).
University of Arizona, Tucson (UA).
University of California, Davis (UCD).

The holotype of *P. yoda* was borrowed from the Mississippi Entomological Museum, Mississippi State University. Richard L. Brown, director, has graciously allowed us to deposit the type in the USNM on indefinite loan. We would also like to thank Norita Chaney, Mike Schauff and Gene Taylor for taking the scanning electron photographs used here.

The New World species of *Polemistus* represent at least two, and possibly three,

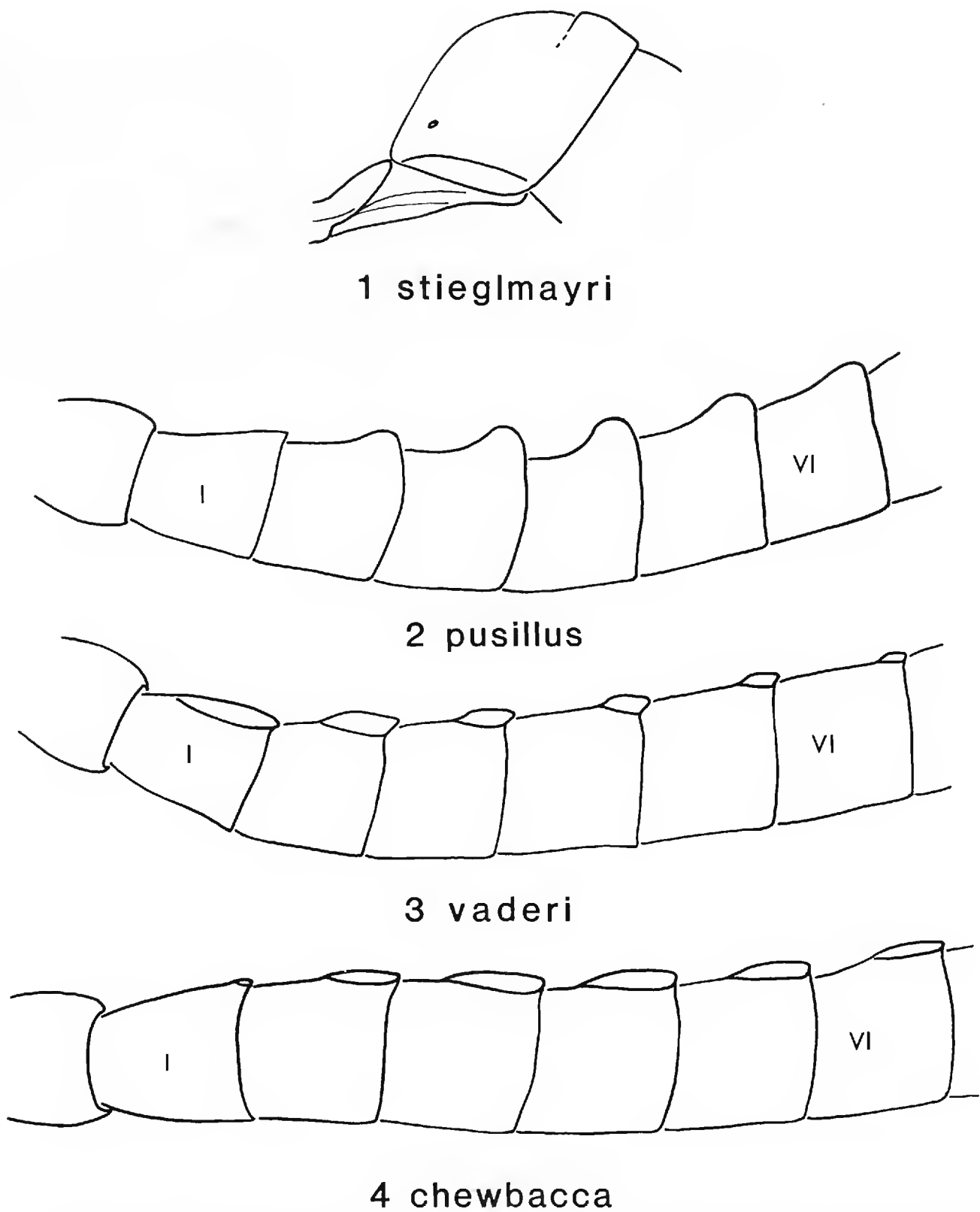
species groups. In the *pusillus* group (*pusillus*, *dickboharti*, *yoda*) the clypeus is densely, evenly covered by appressed silver setae; the clypeal outline, especially in the female, is similar among the species, and there is a narrow malar space in both sexes (Figs. 8–10, 14, 15); a hypersternaulus is usually present (sometimes very short in *yoda*) (Figs. 5, 6); and terga I–II lack a lateral carina, or it is weak. *Polemistus stieglmayri* appears to belong in the *pusillus* group based on clypeal characters, the presence of a hypersternaulus and the setation of the male abdominal venter, but the frontal swellings (Fig. 23), and the strong lateral carina on terga I–II set the species apart. The remaining species, *chewbacca* and *vaderi*, are closely related to the Palearctic species *abnormis* (Kohl). The *abnormis* group is characterized by having a sparsely or non-silvered female clypeus; a large, deep clypeal emargination bounded by large, blunt teeth (Figs. 12, 13) in the female; no malar space in the female and at most a very narrow one in the male; a strong lateral carina on terga I–II; and by the absence of a hypersternaulus (Fig. 7).

In contrast to the ornately sculptured head and thorax of many Old World species, the New World members of *Polemistus* are rather plain, and species characters are few. In the male the presence or absence of antennal tyli and their form, when present, are diagnostic. The presence or absence of long sternal setae on the male abdominal venter is useful. The outline of the free margin of the clypeus can be distinctive in both sexes but unfortunately the mandibles usually have to be spread or the marginal clypeal setae scraped away in order to view this structure. The shape of the labrum is sometimes distinctive. On the scutum the form of the notaulus pits, and the presence or absence of ridges or foveae adjacent to the scutellum are important. Species group characters are used in conjunction with these. Body sculpture and punctation differ little in New World species, and except in *stieglmayri*, we found no apparent differences on the abdomen. Male genitalia were not examined. The known New World species have a slender spine in the scapal basin just above the antennal sockets. Generally in New World species the integument surface has an imbricate microsculpture (sensu Harris, 1979) as seen at 75×, and the episternal sulcus, omaulus, hypersternaulus, and notaulus are pitted or foveate (the notaulus sometimes obscurely so). In the New World species the sculpture of the propodeal dorsum is coarse and varies from areolate to rugose to rugulose (Harris, 1979). The sculpture changes to finer, parallel, oblique ridging on the propodeal side.

KEY TO NEW WORLD SPECIES OF *POLEMISTUS*

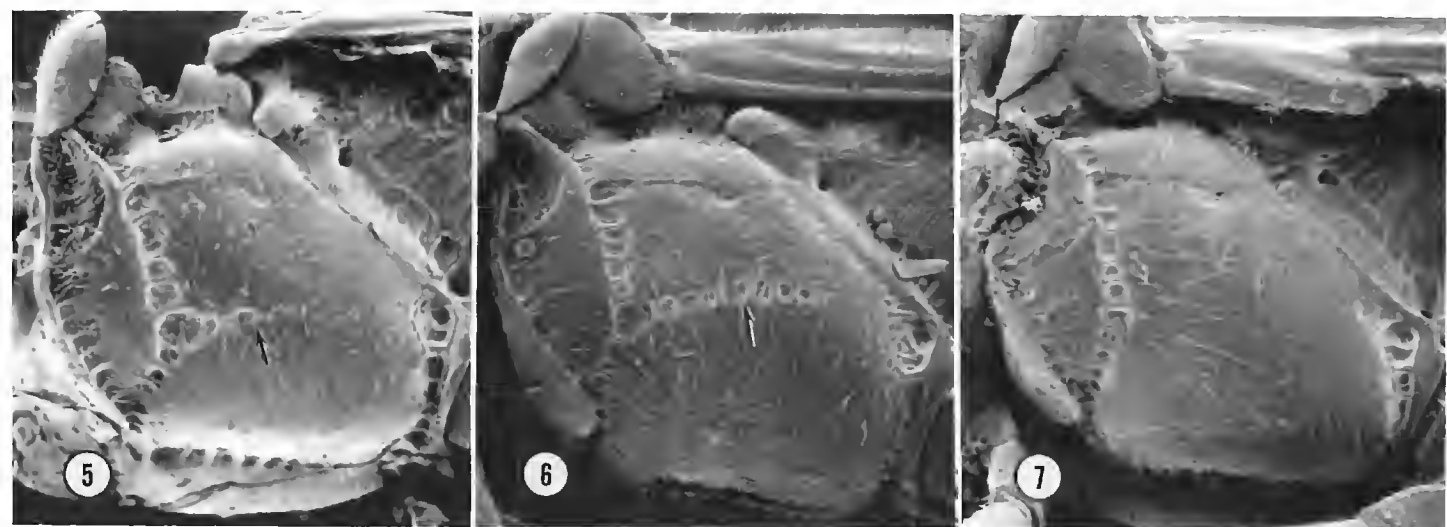
Note: Antennal characters are best seen by using high magnification (75×) and good lighting. Male is unknown for *yoda*.

- 1. Male: Antenna with 13 articles, gaster with 7 visible segments 2
- Female: Antenna with 12 articles, gaster with 6 visible segments 6
- 2. Flagellomeres I–VII without projections or ridges ventrally 3
- Flagellomeres II–IV with projections or ridges ventrally (Figs. 2–4) . . . 4
- 3. Frons without pair of obliquely transverse swellings at upper margin of scapal basin; pronotal collar without sharp transverse carina; hindmargin of gastral sterna IV–V each with pair of long, separated setae; sw. U.S., nw. Mexico *dickboharti* Menke
- Frons with pair of obliquely transverse swellings at upper margin of scapal basin (Fig. 23); pronotal collar with sharp transverse carina; hind-



Figs. 1-4. *Polemistus* species. 1, Left profile of female abdominal petiole and first tergum. 2-4, Profile of male flagellomeres I-VI.

- margin of gastral sterna IV-V each with transverse row of long, pale setae; Brasil *stieglmayri* (Kohl)
4. Hypersternaulus present (Fig. 5); flagellomeres II-V (or VI) with rounded projections apicoventrally (Fig. 2); hindmargin of gastral sterna IV-V each with transverse row of long, pale setae; central Mexico *pusillus* Saussure
- Hypersternaulus absent (Fig. 7); flagellomeres I-V or II-VI with low ridges ventrally (Figs. 3, 4); sterna IV-V without transverse rows of setae; sw. U.S. 5

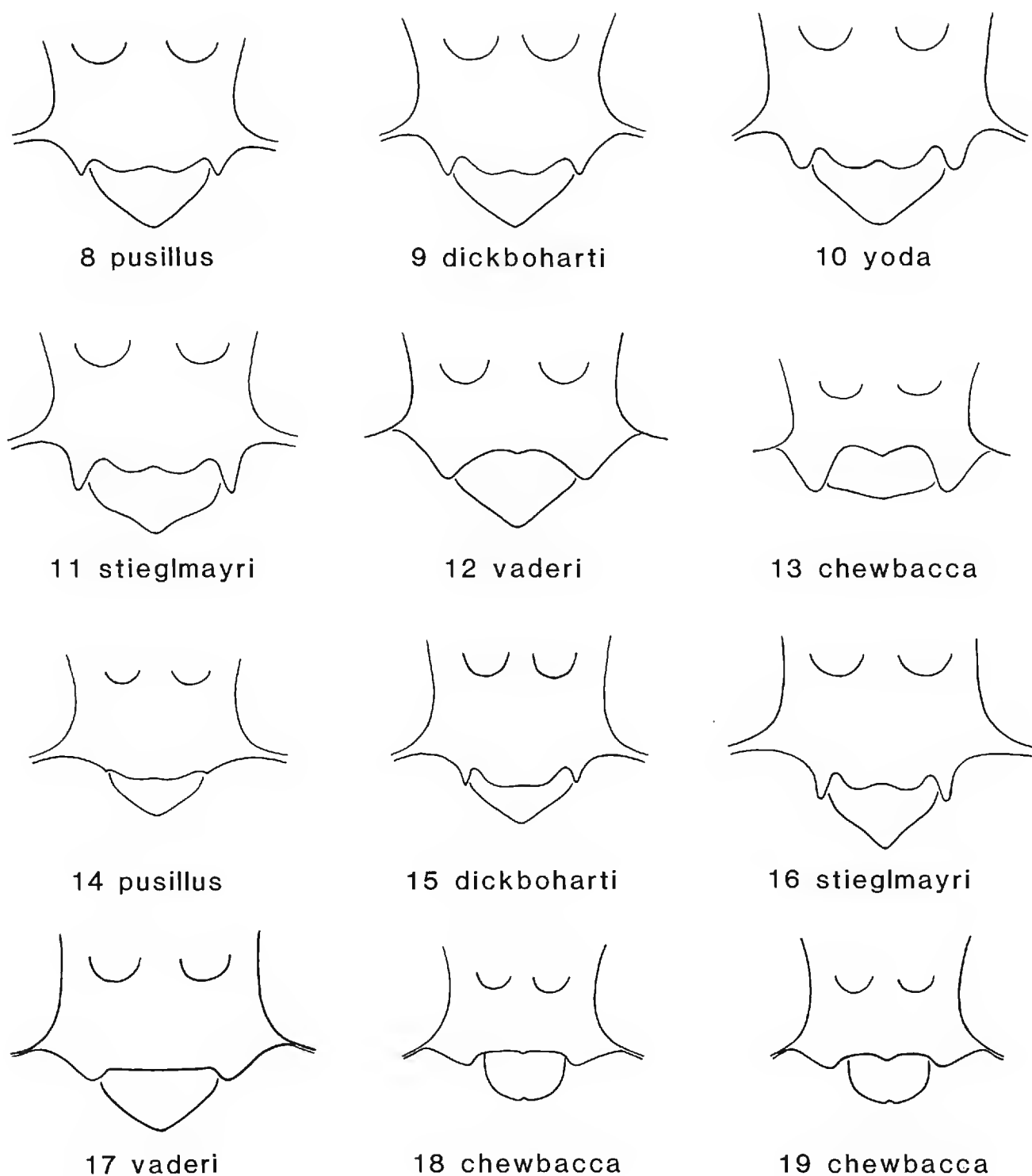


Figs. 5–7. Left mesopleuron of *Polemistus* species, female. 5, *pusillus*. 6, *dickboharti*. 7, *vaderi*.

- 5. Flagellomere I with long ridge, II–IV or V with progressively shorter ridges (Fig. 3); clypeal outline as in Fig. 17 *vaderi* Vincent
- Flagellomere I at most with weak apical process, II–VI with long, prominent ridges (Fig. 4); clypeal outline as in Figs. 18, 19 .. *chewbacca* Menke
- 6. Hypersternaulus absent (Fig. 7); clypeus arcuately uni- or bi-emarginate (Figs. 12, 13), its surface with few silver setae only near apex 7
- Hypersternaulus present as row of large pits (Fig. 6) (if weak, following clypeal characters diagnostic); clypeus sinuately emarginate (Figs. 8–11), its surface uniformly, moderately covered by appressed silver setae ... 8
- 7. Labrum triangular apically (Fig. 12); clypeal outline as in Fig. 12; Utah, Ariz., New Mexico *vaderi* Vincent
- Labrum truncate apically (Fig. 13); clypeal outline as in Fig. 13; se. Ariz. *chewbacca* Menke
- 8. Notaulus ending posterad in large circular depression whose diameter equals that of hindocellus (Fig. 20), depression usually sharply rimmed cephalad when viewed from rear; central Mexico *pusillus* Saussure
- Notaulus not ending posterad in large circular depression, or if so, it is vague and no more than $\frac{2}{3}$ diameter of hindocellus (Figs. 21, 22) 9
- 9. Frons with pair of obliquely transverse swellings at upper margin of scapal basin (Fig. 23); middle lobe of clypeus exceeded by lateral teeth (Fig. 11); Brasil *stieglmayri* (Kohl)
- Frons without swellings at upper margin of scapal basin; middle lobe of clypeus on line drawn between lateral teeth (Figs. 9, 10) 10
- 10. Scutal surface next to scutellum with short, longitudinal or oblique rugulae (Fig. 21); hypersternaulus often extending posterad beyond level of scrobe, pits of hypersternaulus well defined (Fig. 6); sw. U.S., nw. Mexico *dickboharti* Menke
- Scutal surface without rugulae posteriorly; hypersternaulus not extending beyond level of scrobe, often shorter, pits of hypersternaulus becoming indistinct posterad; El Salvador, Honduras, Nicaragua *yoda* Vincent

Polemistus pusillus Saussure
(Figs. 2, 5, 8, 14, 20)

Polemistus pusillus Saussure, 1892:567. Holotype male, “Mexico calida (Cor-



Figs. 8-19. Clypeal and labral outlines of *Polemistus* species. 8-13, Females. 14-19, Males (19 is holotype).

doaba)" (Geneva). Bohart and Menke, 1976:185 (listed). *Passaloecus pusillus*, Rau, 1943:648 (biology).

Diagnosis.—The sawtooth-like projections of the tyli on male flagellomeres II-V or VI (Fig. 2), and the large, deep last notaular pit (diameter equal to hindocellus) in the female (Fig. 20) are diagnostic for *pusillus*. The anterior side of the last notaular pit usually is sharply margined by a ridge which may extend sinuately between both notauli. A number of parallel microridges usually precede it. The bottom of the last pit is smooth and polished. Males also have the large notaular pit but sometimes it is smaller than the hindocellus.

The labrum is triangular in *pusillus*. It and the clypeus are shown in Figs. 8, 14. The scutum is unridged posteriorly except in one female where three weak rugulae can be seen. The hypersternaulus extends posterad to the level of the scrobe in males, slightly beyond in females (ends about half way to mesopleural

pit, Fig. 5). Terga I and II lack a lateral carina. In the male sterna IV–V have transverse rows of long, whitish setae posteromedially which stand out against the short vestiture of the rest of the venter.

Saussure identified his type as a female, but it is a male and the abdomen is now missing.

Distribution.—This species is known only from central Mexico. Records of *pusillus* from the United States (Bohart and Menke, 1976:185; Krombein, 1979:1606) are based on misidentified material of *dickboharti*.

Material studied.—MEXICO, Guerrero, Acapulco, 1939–40, biological note #2480, P. Rau, 2 ♀, 2 ♂ (USNM). Jalisco, Guadalajara, July 21, McClendon, 1 ♂ (ANSP). Morelos, Cuernavaca, 5500', May 22, June 18, 1959, H. E. and M. A. Evans, 2 ♀ (CUI); 5 mi. e. Cuernavaca, March 29, 1962, F. D. Parker, 1 ♀ (UCD). Vera Cruz, Cordoba, type ♂ (Geneva).

Biology.—Rau (1943) found *pusillus* nesting in vacant mud cells of a *Trypoxylon* species. Each cell was provisioned with 6–8 aphids of the genera *Aphis* and *Macrosiphum*, and the entrance to the nest was sealed with a "transparent, glasslike substance." Some cells were partitioned with the same material. Chrysidid cleptoparasites of the genera *Omalus* and *Chrysis*, and a torymid parasitoid of the genus *Monodontomerus* were found in some *pusillus* cells.

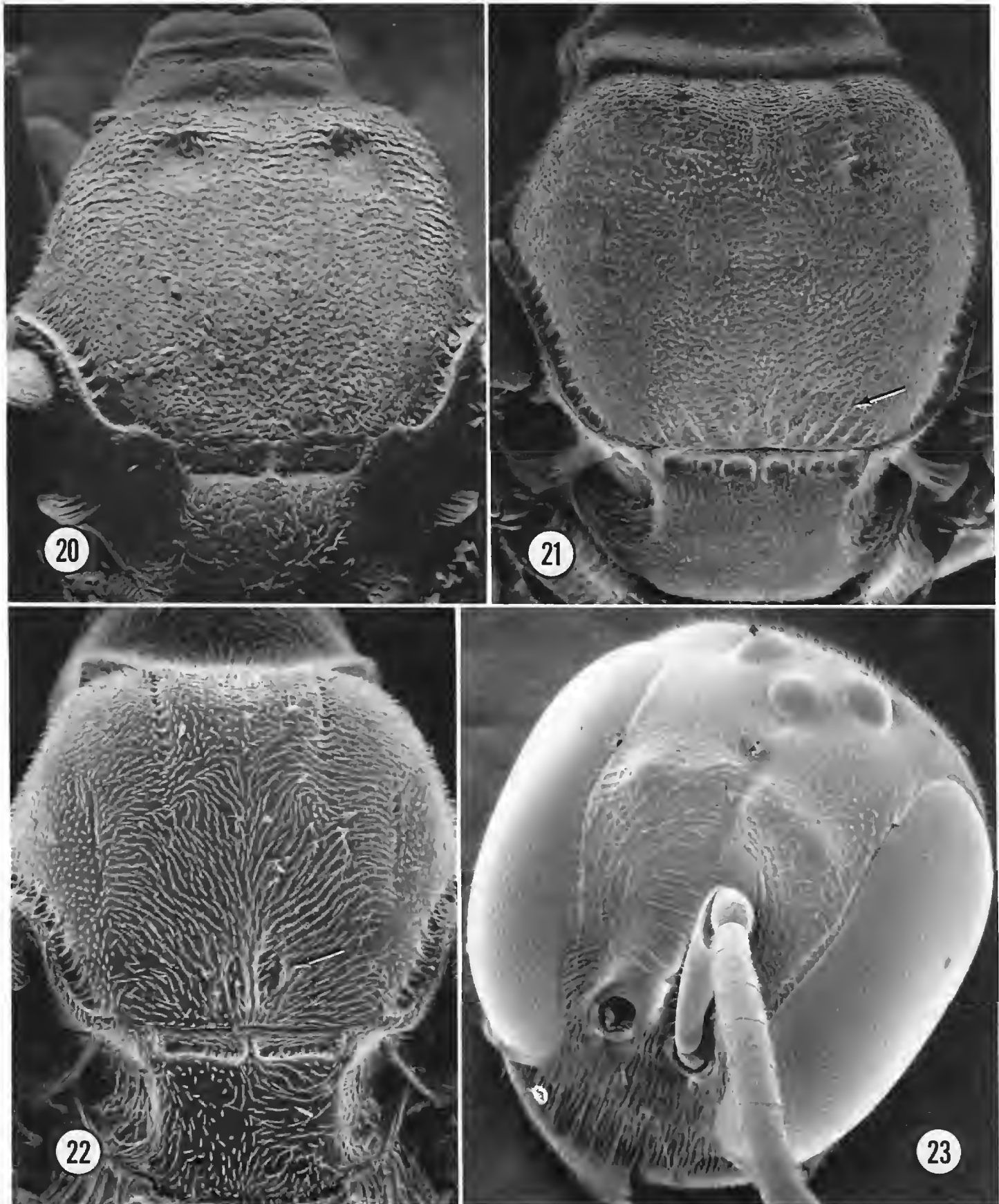
***Polemistus dickboharti* Menke, NEW SPECIES**
(Figs. 6, 9, 15, 21)

Holotype male.—Black except as follows: pale yellow: palpi, tegula; brownish yellow: ventral surface of scape, pedicel and basal flagellomeres; fore and midlegs except coxae and posterior surface of midfemur; hindtrochanter, basal half of hindtibia, hindtarsus. Tegula brown.

Clypeus and lower frons densely covered with appressed silver setae which obscure surface. Sterna IV–V each bearing a pair of separated, long, erect setae on posterior margin.

Scapal basin crossed by many fine, irregular ridges, the lower of which curve downward laterally; frons above scapal basin finely punctate (75×), punctures 2–3 diameters apart; inner orbit paralleled by crenulate carina opposite scapal basin; upper two thirds of outer orbit with similar non-crenulate carina; flagellomeres without tyli ventrally; free edge of clypeus with lateral tooth, weakly bilobate mesally (Fig. 15); labrum triangular apically (Fig. 15). Scutum densely micro-punctate (75×), punctures separated by less than puncture diameter, scutum with longitudinal rugulae next to scutellum which are oblique laterally (similar to Fig. 21); last pit of notaulus largest, its diameter approximately equal to one half diameter of hindocellus; hypersternaulus extending posterad nearly to mesopleural pit; scrobal sulcus represented by horizontal crest between scrobe and episternal sulcus. Terga I–II without lateral carina. Length 4.5 mm.

Variation in males.—The fore and midfemora are sometimes suffused with brown except at their apices. The tegula varies from brown to translucent yellow. The last notaular pit varies in size. It may be no larger than the other pits, and in one specimen it is as large as a hindocellus. The pleuron between the scrobal sulcus and hypersternaulus sometimes is polished and lacks microsculpture. In



Figs. 20-23. *Polemistus* species. 20-22, Dorsal view of female scutum and scutellum. 20, *pusillus*; 21, *dickboharti*; 22, *stieglmayri*. 23, Face of *stieglmayri* showing transverse swellings below ocelli.

the single male from California, the carina along the inner orbit is not crenulate, and the scutum does not have rugulae at its posterior border.

Female.—As in male except: labrum and mandible brownish, flagellum usually dark brown except for pale venter of flagellomeres I-II. Tegula translucent yellow. Occasionally all legs yellow, but usually hind leg brownish except for trochanter and base of tibia.

Clypeus and lower frons moderately, uniformly covered with appressed silver

setae, surface partially obscured; clypeal outline as in Fig. 9. Last pit of notaulus usually about same size as others, but not exceeding two thirds diameter of hindocellus; scutum lacks rugulae posteriorly in specimen from Aduana, Mexico; hypersternaulus extends posterad two thirds to three fourths distance to mesopleural pit (Fig. 6). Length 4–5 mm.

Discussion.—This species is similar to *pusillus*. Females have the same clypeal outline, but the very large last pit of the notaulus (equal to diameter of hindocellus) in *pusillus* (Fig. 20) contrasts with the smaller last pit in *dickboharti* (no more than two thirds diameter of hindocellus and often much smaller, Fig. 21). Also females of *dickboharti* nearly always have rugulae along the hind margin of the scutum (Fig. 21). In most *pusillus* females (and those of *yoda* also) the scutum is plain posteriorly. Males of *dickboharti* separate easily from those of *pusillus* on the basis of the simple flagellomeres. The basal flagellomeres in *pusillus* males have prominent, sawtooth-like tyli ventrally (Fig. 2). The lateral tooth of the male clypeus is much larger in *dickboharti* (Fig. 15) than in *pusillus* (Fig. 14). Males of *dickboharti* lack the transverse rows of long setae found in males of *pusillus*; instead there are two long, separated setae on sternum IV–V.

Etymology.—With great affection I dedicate this species to Dick Bohart, a dear friend, colleague, and mentor.

Distribution.—Arizona, southern Utah, southern California, and Sonora, Mexico.

Types.—Holotype ♂: ARIZONA, *Cochise Co.*, Portal, 5000', Sept. 5, 1959, H. E. Evans (CUI). Fifteen ♂, 22 ♀ paratypes as follows: ARIZONA, *Cochise Co.*, same place as type, on honey dew on walnut, Sept. 2–12, 1959, H. E. Evans, 4 ♂ (CUI); 1 mi. ne. Portal, on walnut, Sept. 7, 1959, J. R. Powers, 1 ♀ (CAS); 3 mi. ne. Portal, on Agave, July 22, 1964, G. D. Butler, 1 ♀ (UCD); Southwest Research Station, 5400', 5 mi. w. Portal, on honey dew on *Populus*, Aug. 3–Sept. 12, 1959, H. E. Evans, 9 ♂, 2 ♀ (CUI); same place, July 3–13, 1963, J. Rozen, D. Oliver, A. Moldenke, J. Woods, 5 ♀ (AMNH, UCD); same place, July 11–14, 1965, V. Roth, 2 ♀ (AMNH, UCD); Huachuca Mtns., June 26, 1940, R. A. Flock, 1 ♀ (UCD); Miller Canyon, 6000', 1 mi. w. parking area, July 16, 1964, M. Noller, 1 ♂ (UCD). *Graham Co.*, 0.9 mi. along road to Marjilda Canyon from highway 666, 3860', Aug. 3, 1965, H. B. Leech, 1 ♀ (CAS). *Gila Co.*, 3 mi. sw. Christmas, June 5, 1962, malaise trap by *Condalia*, F. Werner, 1 ♀ (UCD). *Navajo Co.*, Carrizo, June 21, 1957, Butler and Werner, 1 ♀ (UCD). *Pima Co.*, Tucson, April 14, 1940, R. H. Crandall, 1 ♀ (UCD); 27 mi. se. Tucson, May 29, 1965, M. E. Irwin, 1 ♀ (UCD); Sabino Canyon, Santa Catalina Mtns., May 11, 1961, R. and E. Painter, 1 ♀ (UCD). *Santa Cruz Co.*, Patagonia, on *Cessia leptocarpa*, July 29, 1962, M. Noller, P. Johnson, 1 ♀ (UCD); Canelo, Aug. 3, 1956, G. Butler, 1 ♂ (UCD). UTAH, *Garfield Co.*, Bryce Canyon, June 18, 1947, G. Bohart, 1 ♀ (UCD). *Washington Co.*, St. George, June 15, 1930, E. W. Davis, 1 ♀ (USNM). MEXICO, *Sonora*, Nogales, 1 ♀ (BMNH).

The following nonparatypic material has been seen: ARIZONA: *Cochise Co.*, Douglas, Sept. 19, 1933, W. W. Jones, 1 ♀ (USNM); Southwest Research Station, 5 mi. w. Portal, 5400', Sept. 16, 1963, V. Roth, 1 ♀ (AMNH). CALIFORNIA, *San Diego Co.*, Palm Canyon, Borego, May 3, 1945, A. Melander, 1 ♂ (USNM). MEXICO, *Sonora*, Aduana, March 15, 1962, L. Stange, 1 ♀ (UCD).

***Polemistus yoda* Vincent, NEW SPECIES**

(Fig. 10)

Holotype female.—Black except as follows: yellow: scape ventrally, mandible (apex brownish), palpi, pronotal lobe; yellow brown: labrum, ventral surface of pedicel and flagellum (last few flagellomeres darker), foreleg (except outer surface of tibia yellow), midleg (except femur black with extreme apex brownish), hind-trochanter and tarsus; hindtibial base yellow. Tegula translucent yellow anteriorly, dark brown posteriorly.

Clypeus, lower frons, propleuron posteriorly and forecoxa ventrally densely covered by appressed silver setae which obscure surface.

Scapal basin irregularly, finely cross carinulate; frons above scapal basin finely punctate (75×), punctures 1-2 diameters apart; inner orbit closely paralleled by fine carina opposite scapal basin, upper two thirds of outer orbit with similar carina; clypeal outline as in Fig. 10; labrum triangular apically (Fig. 10). Scutum densely micropunctate (75×), punctures separated by less than puncture diameter; notaulus pits sharply formed, uniform in width; hypersternaulus ending posterad at level of scrobe, pits of hypersternaulus smaller, shallower than those of episternal sulcus; scrobal sulcus represented by horizontal crest between scrobe and episternal sulcus. Terga I-II with weak lateral carina. Length 4.5 mm.

Male.—Unknown.

Variation in female.—The hypersternaulus is weakly indicated in both paratypes. It does not reach the level of the scrobe and only the first pit is large and clearly formed.

Discussion.—Females of *P. yoda* are most similar to those of *dickboharti*, but the ridging along the posterior margin of the scutum in the latter (Fig. 21) contrasts with the plain scutum of the former. *Polemistus yoda* has weak lateral carinae on terga I-II, but these are absent in *dickboharti* and *pusillus*. Also these last two species lack the dense appressed silver setae found on the propleuron and forecoxa of *yoda*.

Etymology.—The name *yoda*, a noun in apposition, is based on a character in the movie "The Empire Strikes Back."

Distribution.—El Salvador, Honduras, and Nicaragua.

Types.—Holotype ♀: NICARAGUA, 14 km. sw. Camoapa, swept from doorway *Gossypium hirsutum*, Dec. 1, 1976, W. H. Cross (USNM). Two ♀ paratypes as follows: HONDURAS, Tegucigalpa, June 12, 1918, F. J. Dyer (USNM). EL SALVADOR, 2 and one half mi. w. Quezaltepeque, July 12, 1961, M. E. Irwin (UCD).

***Polemistus stieglmayri* (Kohl)**

(Figs. 1, 11, 16, 22, 23)

Passaloecus stieglmayri Kohl, 1905:359. Holotype female, "Brasilien (Rio Grande do Sul)" (Vienna). Kohl, 1905:529 (listed). *Polemistus stieglmayri*, Bohart and Menke, 1976:185 (listed).

Diagnosis.—The pair of oblique swellings on the frons above the scapal basin are unique to *stieglmayri* (Fig. 23). The absence of tyli on the male flagellum and the long clypeal teeth (Figs. 11, 16) are also distinctive. The labrum is triangular

apically. In both sexes the scutum usually has a pair of longitudinally elongate foveae posteromedially which are narrowly separated by a septum (Fig. 22). In some specimens these two foveae are broad, roughly triangular depressions which fade laterally and may contain rugulae. The notaulus pits are uniform in size. The hypersternaulus extends posterad to or just beyond the level of the scrobe. Terga I and II have a lateral carina. Tergum I sometimes has a strong transverse subapical impression which, when viewed in lateral profile, results in a humped outline (Fig. 1). This impression is quite weak in two thirds of the specimens at hand. The posterior margin of sterna IV–V in males of *stieglmayri* bear transverse rows of long, pale setae, a feature shared with *pusillus*.

Distribution.—Known only from southern Brasil.

Material examined.—BRASIL, *Rio Grande do Sul*, no specific locality, Stieglmayr, ♀ type (Vienna). *Santa Catarina*, Nova Teutonia, Nov.–Feb. 1964–65, Fritz Plaumann, 8 ♀, 1 ♂ (UCD).

***Polemistus vaderi* Vincent, NEW SPECIES**

(Figs. 3, 7, 12, 17)

Holotype male.—Black except as follows: pale yellow: scape and pedicel ventrally, palpi, pronotal lobe, tegula, fore and midtibiae and tarsi, basal half of hindtibia; brownish yellow: fore and midtrochanter ventrally and hindtrochanter; closing face of fore and midfemora yellow, brown above; hindtarsi brownish.

Clypeus and lower frons densely covered by appressed silver setae which obscure surface.

Scapal basin crossed by many fine, irregular ridges which curve downward laterally; frons above scapal basin finely punctate (75×), punctures 2–3 diameters apart; inner orbit closely paralleled by fine carina opposite scapal basin; upper two thirds of outer orbit with similar carina; flagellomeres I–IV with low ridgelike tyli ventrally, those on I–II extending the length of each flagellomere, those on III–IV shorter, occupying apical one half and one third, respectively (similar to Fig. 3); free edge of clypeus as in Fig. 17; labrum roundly triangular apically (Fig. 17). Scutum densely micropunctate (75×), punctures separated by less than puncture diameter; notaulus pits shallow, ill defined laterad; propodeal side with many fine, parallel, oblique ridges which reach metapleural sulcus; scrobal sulcus represented by horizontal crest between scrobe and episternal sulcus; hypersternaulus absent although episternal sulcus pits enlarged at that level of pleuron. Terga I–II with lateral carina. Length 4.5 mm.

Variation in males.—In some specimens the fore and midlegs are entirely yellow except the coxae, and the basal flagellomeres are yellowish beneath. Tyli occur on the first six flagellomeres in some specimens, but those on III–VI are represented by very short apical tooth-like elevations. The tylus on flagellomere II sometimes is restricted to the apical two thirds or one half of the article (Fig. 3). The notauli are sometimes weakly impressed and the pitting obscure.

Female.—As in male except: mandible apex, labrum, and fore and midtrochanters brownish black; forefemur brownish black except yellow on apical one fourth; midfemur yellow only at extreme apex. Clypeus with few appressed silver setae near apex, surface not obscured; appressed silver setae on frons between eye and scapal basin only partially obscure surface; scapal basin shining, without ridges; frons between scapal basin and eye with feeble, vertical microridges; carina

along inner orbit short, weak; outer orbit without such carina; free edge of clypeus with large, deep, semicircular emargination containing a weak central tooth (Fig. 12); clypeal surface shining, broadly concave; labrum triangular apically. Length 4.5-6 mm.

Discussion.—The broad, deep, semicircular clypeal emargination and triangular labrum of the female (Fig. 12), and the presence of a long tylus on the first male flagellomere (Fig. 3) are diagnostic for *vaderi*. The absence of a hypersternaulus (Fig. 7) and the absence in the female of dense silver clypeal setae relate *vaderi* to *chewbacca*, but the latter has a truncate labrum in the female (Fig. 13), and flagellomere I has at most a short apical tylus in the male (Fig. 4). The clypeal outlines also differ between these species (compare Figs. 12, 13).

Etymology.—This species is named after Darth Vader, a character in the movies "Star Wars" and "The Empire Strikes Back."

Distribution.—Utah, Arizona and New Mexico.

Types.—Holotype ♂: UTAH, *Beaver Co.*, Beaver Mountain, 6000-7000', rearing code BM 6-B, Aug. 1972, D. Vincent (USNM). Seven ♂ and 3 ♀ paratypes as follows: ARIZONA, *Cochise Co.*, Southwest Research Station, 5 mi. w. Portal, 5400', July 8, 1963, J. Rozen, D. Oliver, A. Moldenke & J. Woods, 1 ♀ (AMNH); same location, Aug. 29, 1959, H. E. Evans, 1 ♂ (CUI); same location, Sept. 13, 1959, on honey dew on *Populus*, H. E. Evans, 1 ♂ (CUI). NEW MEXICO, *Lincoln Co.*, Capitan Mountains, May 26, 1907, ex galleries of *Dendroctonus convexifrons*, Hopkins #5470b, J. L. Webb, 1 ♂ (USNM); *San Miguel Co.*, 5 mi. nw. Las Vegas, reared from galls of *Andricus ruginosus* Bassett, April 29, 1918, Hopkins #15602, L. H. Weld, 3 ♂ (USNM). UTAH, same data as holotype, rearing codes BM 6-C, BM 5-B, BM 3-B, 1 ♂, 2 ♀ (USNM).

Biology.—Four trap nests from the holotype locality were examined. The nests were constructed in 2.0 × 32.0 mm trap-nest borings in soft pine blocks. The trap-nest blocks were placed at the site in June 1972 and recovered in August 1972. Partitions and closures ranged from 0.5 to 2.0 mm thick and were made of pale yellow translucent resin. Three nests contained one brood cell each, and one nest contained two brood cells. Brood cells ranged from 12.0 to 20.0 mm long. Each nest had a single vestibular cell which ranged in length from 6.0 to 15.5 mm. Four of the five developing larvae spun a single, vestigial cocoon consisting of a delicate, transverse, silken partition immediately anterior to the larva's head. The larva of the female from the same nest as the holotype spun two of these silken partitions a few millimeters apart. Fecal pellets were deposited at the rear of each brood cell. Aphids were the prey but the number used per cell could not be determined.

Polemistus chewbacca Menke, NEW SPECIES

(Figs. 4, 13, 18, 19)

Holotype male.—Black except as follows: yellow: ventral surface of antenna (yellow changes to brownish yellow toward apex), trochanters ventrally, apex of fore and midfemora, fore and midtibiae, basal half of hindtibia, all tarsi; pale yellow: palpi, pronotal lobe and tegula.

Clypeus and lower frons densely covered by appressed silver setae which obscure surface.

Scapal basin nearly smooth, with scattered, weak, fine, transverse ridges; ex-

tremely fine scattered punctures visible (75 $\times$) on frons below ocelli, punctures 2–3 diameters apart; no carina paralleling inner or outer orbits; flagellomere I with weak toothlike tylus apicoventrally, flagellomeres II–VI with low ridgelike tyli ventrally, that on II visible only on apical one fourth, those on III–V extending length of each flagellomere, that of VI occupying outer three fourths of flagellomere (Fig. 4); free edge of clypeus as in Fig. 18; labrum arcuate apically, weakly indented medially (Fig. 18). Scutum with extremely fine punctures anteriorly (75 $\times$), punctures 1–2 diameters apart; notaulus weakly impressed, not clearly pitted; propodeal side smooth, shining adjacent to metapleuron but changing to oblique parallel ridging and areolation dorsad; scrobal sulcus represented by crest between scrobe and episternal sulcus; hypersternaulus absent. Terga I–II with lateral carina, but carina on I weak. Length 4.5 mm.

Variation in male.—The antennal tyli occupy only the apical one half to three fourths of flagellomeres II–VI in one specimen, the apical three fourths on V–VI in three specimens, and in one of these last the tyli on II–IV are full length. In one specimen the propodeal side is ridged to the metapleuron and the dorsum is broadly rugose. The angle at the center of the clypeal notch is more prominent in the paratypes (Fig. 19).

Female.—As in male except: mandible apex and labrum brownish, trochanters sometimes completely yellow. Clypeus with few appressed silver setae near apex, surface not obscured. Free edge of clypeus deeply bi-emarginate, its lateral lobes reflexed (Fig. 13); clypeal surface shiny; labrum truncate (Fig. 13); scutal punctation obscure at 75 $\times$. Terga I–II with strong lateral carina. Length 4.5–5 mm.

Discussion.—The bi-emarginate female clypeus (Fig. 13), the rounded male labrum, and the absence of a long tylus on male flagellomere I (Fig. 4) are diagnostic for *chewbacca*. The absence of a hypersternaulus and the sparsely silvered female clypeus relate *chewbacca* to *vaderi*, but the latter has a semicircular clypeal emargination in the female (Fig. 12), the labrum is triangular in the female (Fig. 12), and flagellomere I has a long tylus in the male (Fig. 3). The male clypeal and labral outlines also differ between these two species (compare Figs. 17–19).

Etymology.—The name *chewbacca*, a noun in apposition, is based on a rather wild looking but friendly beast in the movies “Star Wars” and “The Empire Strikes Back.”

Distribution.—Southeastern Arizona.

Types.—Holotype δ : ARIZONA, Cochise Co., Southwest Research Station, 5 mi. w. Portal, 5400', Sept. 9, 1959, H. E. Evans (CUI). Four δ and 3 η paratypes as follows: ARIZONA, same locality as type, Aug. 20, 23, 29, Sept. 9, 13, 1959 (one on honey dew on *Populus*), H. E. Evans, 2 δ , 3 η (CUI); Huachuca Mts., 5000', June 14, 1920, A. A. Nichol, 1 η (USNM); Miller Canyon, 6000', 1 mi. w. parking area, Huachuca Mts., July 16, 1964, M. Noller, 1 δ (UA).

LITERATURE CITED

- Bohart, R. M., and A. S. Menke. 1976. Sphecoid wasps of the world. Univ. Calif. Press, Berkeley, ix + 695 pp.
- Harris, R. A. 1979. A glossary of surface sculpturing. Occ. Papers Ent., Calif. Dept. Food Agric., no. 28, 31 pp.
- Kohl, F. F. 1905. Hymenopteren aus der neotropischen Fauna. Verhandl. zool.-bot. Ges. Wien 55: 338–366.

- . 1905. Zur Kenntniss der Hymenopterengattung *Passaloecus* Shuck. Verhandl. zool.-bot. Ges. Wien 55:517-529.
- Krombein, K. V. 1979. Superfamily Sphecoidea, pp. 1573-1740. In: Krombein *et al.*, Catalog of Hymenoptera in America north of Mexico, vol. 2. Smithsonian Institution Press, Washington DC.
- Rau, P. 1943. The nesting habits of certain sphecid wasps of Mexico, with notes on their parasites. Ann. Ent. Soc. Amer. 36:647-653.
- Saussure, H. de. 1892. Histoire naturelle des Hymenopteres, pp. 177-590 in vol. 20. In: Grandidier, Histoire physique, naturelle, et politique de Madagascar. Paris.

The Classification of the Lithurginae (Hymenoptera: Megachilidae)¹

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The Lithurginae is a small world-wide subfamily of Megachilidae, with its maximum diversity in the arid temperate parts of South America. Its position relative to related groups of bees is indicated in Fig. 1. The synapomorphies shown in the figure and in Table 1 are not an exhaustive list but only enough to establish the cladistic relationships and to characterize the major taxa related to the Lithurginae. Peters (1972) has provided a similar list and come to conclusions similar to mine, although he did not consider the diversity of Lithurginae here discussed. The Fideliidae are considered as a subfamily of Megachilidae by Rozen (1977) and this position for that group may be quite appropriate. My placement of it here as a family does not indicate a strong conviction as to its status.

The definition of the Lithurginae given by Michener (1944) is not correct, as noted by Moure (1949). (In 1944 I had not seen South American material of the subfamily, and my comments were based on a limited sample of the species of the genus *Lithurge*.) Thus the jugal lobe of the posterior wing, while generally longer in Lithurginae than in Megachilinae, is only half as long as the vannal lobe in *Trichothurgus colloncurensis* Ogloblin. The hindtibiae lack spicules in many males and the spicules are weak, especially in *Trichothurgus*. The face of the female is often not elevated below the antennal sockets in *Trichothurgus*. The epistomal suture is often complete, even in some species of *Lithurge*. Finally, in *Trichothurgus* the lowest rather than the middle mandibular tooth is often longest and the middle one is not always advanced in front of the others, as in *Lithurge* and *Microthurge*.

Characteristic features of Lithurginae include the following: *Synapomorphies*: Characters 8 to 14, Table 1. *Plesiomorphies*: Jugal lobe of hindwing half to three fourths as long as vannal lobe. Basitibial plate usually defined along posterior margin and at apex in female, but not evident in several species of *Trichothurgus*. Metasoma of male not curled under at apex as in most megachilids; sixth tergum without transverse carina, teeth, and the like; seventh tergum fully exposed and directed posteriorly. Six sterna fully exposed. Pygidial plate of female represented by a longitudinal, dorsal, bare zone on sixth tergum, extended posteriorly as flat or concave dorsal surface of apical tergal projection or spine, sometimes expanded at apex; of male a broader plate, margined laterally by carinae, often pointed apically and quite slender, almost like an apical tergal spine.

A common feature of the subfamily found in females of nearly all *Lithurge*, all

¹ Contribution number 1839 from the Department of Entomology, University of Kansas, Lawrence, Kansas 66045.

This paper is dedicated with pleasure and enthusiasm to Dr. Richard M. Bohart, in recognition not only of his seventieth birthday but of his life-long work as a hymenopterist and as a teacher of systematic entomology. A new species, *Microthurge boharti*, is named in his honor.

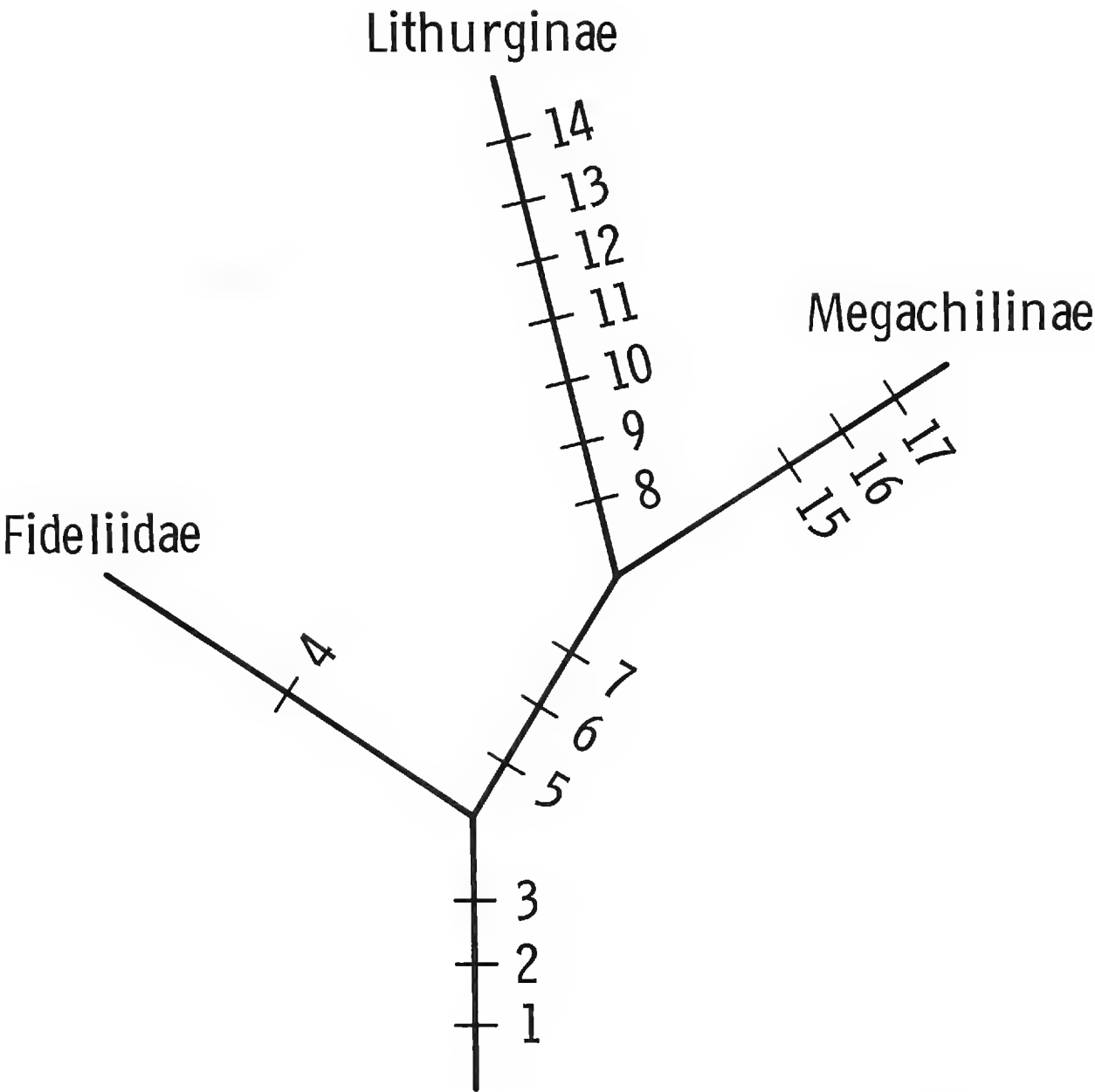


Fig. 1. Cladogram showing the position of Lithurginae. Numbers represent the apomorphies listed in Table 1.

Microthurge, and a few *Trichothurgus*, and in males of a few species of *Lithurge* (e.g., *L. fortis* Cockerell) and *Microthurge*, is a facial prominence. This is an elevation near the median segment of the epistomal suture. Sometimes the suture, if discernible, is largely above it so that the prominence is on the upper part of the clypeus or largely so [*T. osmioides* (Friese), *wagenknechti* (Moure)]; *L. rubricatus* Smith). Sometimes the suture is below it, so that the prominence is on the supraclypeal area or largely so [*T. dubius* (Sichel), *Lithurgopsis*, *Microthurge*]. In still others both areas are involved, so that the suture goes across the prominence (*L. sparganotes* Schletterer, *atratus* Smith, *scabrosus* Smith, etc.).

Other features useful in recognizing the subfamily are the tridentate mandibles, with the middle tooth the longest except in *Trichothurgus*. Arolia are absent or nearly so in all females and some males.

Another interesting feature of the subfamily is the structure of the apex of the labial palpus. Attached to the end of the very long second segment is the small, flattened third segment, which continues in the same direction as the second and is often somewhat pointed. Only the fourth segment, when present, diverges from the axis of the preceding segments. In most long-tongued bees both third and

Table 1. Synapomorphies indicated in Fig. 1, with explanations or plesiomorphies in parentheses.

1.	Labrum longer than broad. (The labrum is broader than long in other bees, with the exception of some Nomadinae which must have evolved the elongate labrum independently.)
2.	Scopa on metasomal sterna, not on legs. (No other bees have this feature although some short-tongued bees have sternal in addition to leg scopal hairs.)
3.	Hairy larval bodies. (Most other bees have bare larvae or larvae with only a few minute spicules. Exceptions are allodapine anthophorids which must have evolved hairs independently.)
4.	Hindbasitarsus with long hairs used in flicking soil away from nest entrance. (Not found in other bees.)
5.	Two submarginal cells. (Three is widespread, although reduction to two occurs in many bees.)
6.	Seventh metasomal sternum of male reduced, without large apical lobes. (Seventh metasomal sternum produced to paired thin apical lobes, a widespread feature of short-tongued and some long-tongued bees.)
7.	Volsellae lost or fused to form lobes on gonocoxites; opposable digitis and cuspis not recognizable or at least not moveable. (Although volsellar reduction is common, volsellae are separate sclerites, each with digitis and cuspis, in most bees.)
8.	Proboscis elongate, in repose often reaching metasoma. (With few exceptions other megachilids have shorter proboscides.)
9.	Third segment of labial palpus flattened, on same axis as second. (Third segment directed laterally in nearly all other long-tongued bees.)
10.	Outer surfaces of tibiae, except hindtibiae of some males, with coarse hairless spicules. (Spicules if present bearing an apical hair.)
11.	Hindbasitarsi slender, almost cylindrical. (The hindbasitarsi are flattened in most bees, at least in females.)
12.	First metasomal tergum small, flattened, posterior margin rounded. (In other bees this tergum is more convex in profile with anterior and dorsal surfaces, and has the posterior margin transverse.)
13.	Posterior margin of sixth tergum of female with strong sublateral tooth, completely hidden in dense hair in <i>Trichothurgus</i> . (Such teeth are absent in other megachilids.)
14.	Male genitalia and hidden sterna extraordinarily small. (In other bees these structures are larger and commonly more heavily sclerotic as well as more ornate.)
15.	Basitibial plate completely lost. (Such loss is also common in other bees, although the plate is widespread and presumably plesiomorphic.)
16.	Jugal lobe of hindwing less than half as long as vannal lobe. (The jugal lobe is half or commonly much more than half as long as the vannal lobe in many bees although reduction also occurs in many groups other than megachilids.)
17.	Pygidial plate and pygidial fimbria absent. (Both are present in most bees, although independently lost in various groups; in Fideliidae they may also be lost although the condition found in that group may result from great expansion of the plate.)

fourth segments diverge, although *Prochelostoma* in the Megachilinae resembles the Lithurginae in this feature. The fourth segment of the labial palpus is sometimes absent. It is certainly easily broken off, but seems to be actually absent in males of *Trichothurgus laticeps* (Fries), in all specimens of *Microthurge* examined, and in some Old World species of *Lithurge* (see below).

KEY TO GENERA OF LITHURGINAE

- 1. Labrum longer than clypeus, often much longer. Hindtibia of female rather uniformly hairy on outer and anterior and posterior surfaces, spicules relatively inconspicuous among hairs. Lower mandibular tooth longer than middle tooth or in some females, lower and middle teeth equal.
..... *Trichothurgus*

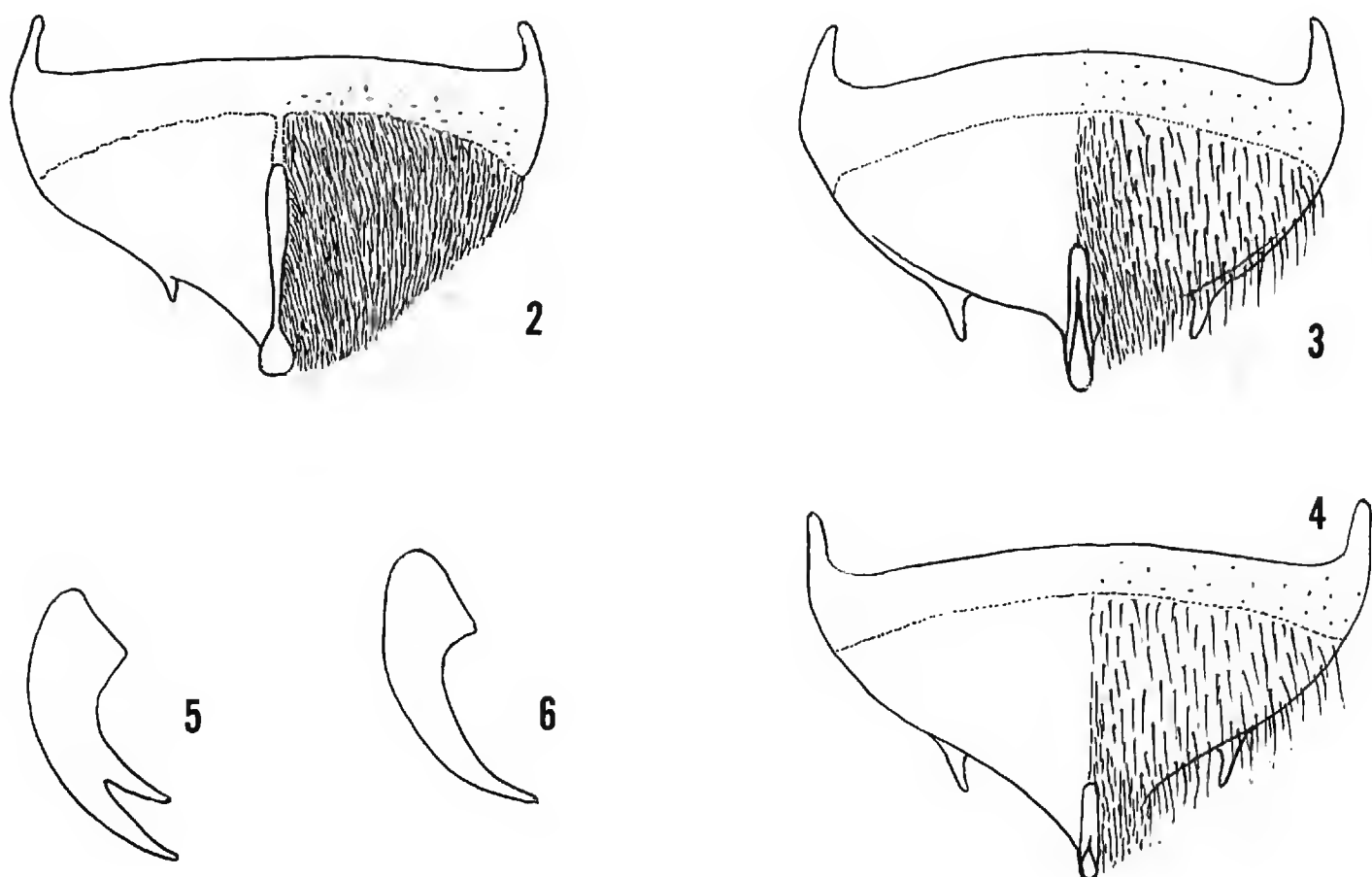
- Labrum about as long as clypeus. Hindtibia of female with hairs of broad, longitudinal outer zone shorter and sparser than those of anterior and posterior surfaces, spicules large and conspicuous in outer zone. Lower mandibular tooth conspicuously shorter than middle tooth, which is longest mandibular tooth: 2
- 2. Body small, slender, heriadiform; claws of female bifid; stigma of moderate size, broadest at base of vein r, sides converging toward base; maxillary palpi 2-segmented. *Microthurge*
- Body broad, megachiliform; claws of female simple; stigma small, sides basal to vein r parallel or nearly so; maxillary palpi 3- or 4-segmented. *Lithurge*

Moure (1949) placed *Trichothurgus* (with *Lithurgomma*) in a separate tribe, the Trichothurgini. While it is the most distinctive genus of Lithurginae, I see no need to segregate it as a tribe, and follow Snelling (in press) in not doing so. Most of its characters are plesiomorphies or probable plesiomorphies. The large and elongate labrum, however, appears to be a synapomorphy uniting the species of *Trichothurgus*, which can be regarded as a sister group to the other two genera combined. The sparsely hairy wing membrane is probably also a synapomorphy although this character arises independently in various other bees.

Lithurge and *Microthurge* agree in several synapomorphies: the reduced lower mandibular tooth such that the middle tooth is longest as well as more anterior than the others, the coarse tibial spicules in areas of short and sparse hairs, the low profile of the posterior part of the thorax and especially of the propodeum, the median apical pygidial spine of the female, the strong tooth lateral to this spine on the posterior margin of tergum VI. Compared to *Trichothurgus* with its many plesiomorphies, *Lithurge* and *Microthurge* have few, the most noteworthy, perhaps, being the ordinary sized labrum and the moderate to high density of hairs on the wing membrane.

Microthurge has few apomorphies. These include the short maxillary palpi and perhaps the larger stigma (plesiomorphic for Apoidea as a whole, no doubt, but perhaps derived in connection with small body size in this genus as well as in some related small megachilids such as *Chelostoma* and *Heriades*). Bifid claws in females (Fig. 5) are considered a plesiomorphy by Peters (1972) in other megachilids, probably correctly, but could be an apomorphy in *Microthurge*. Genes for this character must be retained in all species, because the claws of males are cleft. A minor regulatory change could therefore cause their reactivation in females, and would be apomorphic. The broad pygidial plate of males of *Microthurge* (Fig. 8) seems to be plesiomorphic, as compared to all other megachilids, but one must question this idea in view of the slender produced plate in both *Trichothurgus* and *Lithurge* (Fig. 7). If this similarity is due to homology, then the broad plate of male *Microthurge* is a reversion toward the more primitive apoid condition, but for this genus it would be an apomorphy.

For *Lithurge* the situation is equally confusing. If the stigmal, claw, and pygidial characters listed above are plesiomorphic for *Microthurge*, then the alternative characters are apomorphic for *Lithurge*. Regardless of such matters, there is enough phenetic difference between *Lithurge* and *Microthurge* to justify generic status for them both.



Figs. 2–6. 2–4, sixth metasomal terga of females; 2, *Trichothurgus wagenknehti*, 3, *Lithurge apicalis*, and 4, *Microthurge pharcidontus*. 5, 6, claws of females; 5, *Microthurge pharcidontus* and 6, *Lithurge apicalis*.

The long, slender arolia in males of Lithurginae are of interest. No doubt their presence is plesiomorphic; they occur in both sexes of most bees, but are absent in female lithurgines. They are present in males of *Trichothurgus*, in the Western Hemisphere subgenus *Lithurgopsis* of *Lithurge*, and in one Australian species, *Lithurge* (*Lithurge*) *rubricatus* Smith. They are absent in the rest of the genus *Lithurge* and in *Microthurge*.

Genus *Trichothurgus* Moure

(Fig. 2)

Trichothurgus Moure, 1949:240. Type species: *Megachile dubia* Sichel, by original designation.

Lithurgomma Moure, 1949:277. **New synonym.** Type species: *Lithurgomma wagenknehti* Moure, by original designation.

Commonly robust, hairy bees without metasomal hair bands. Facial prominence commonly absent, present in females of *T. dubius* (Sichel) (clypeal); *osmioides* (Friese), *pseudocellatus* (Moure), and *wagenknehti* (Moure) (all supra-clypeal). Epistomal suture complete. Labrum longer than clypeus, sometimes as long as distance from clypeal apex to anterior ocellus. Mandible with lower tooth longer than median tooth or in females of some species, these two teeth subequal. Maxillary palpus 3-segmented; labial palpus 4-segmented or fourth segment sometimes missing. First flagellar segment over twice as long as greatest breadth [less than twice as long in *osmioides* (Friese)], second much shorter than first and usually distinctly broader than long. Tibiae with anterior, outer, and posterior

surfaces rather uniformly hairy; fore and middle tibiae each with row of small spines or spicules extending basad on posterior outer surface from each of the two apical tibial spines, these rows limited to distal part of tibia and absent in some males; hindtibia with similar spicules scattered among hairs of outer surface in females but not in males. Arolia of male distinct, long, slender (as in *Lithurgopsis*). Claws of female simple. Hindbasitarsus of female subequal to tibia or usually shorter. Stigma small, slender, sides basal to vein r parallel. Wing membrane bare or with sparse hairs. Profile of first metasomal tergum with basal concavity less horizontal than dorsal surface. Pygidial plate of female a dorsal strip on tergum VI, usually slightly expanded at apex, not projecting as a spine; of male a dorsally flat or concave, broad, blunt projection or robust spine, similar to that of *Lithurge* but often hidden by long hair from adjacent parts of tergum. Tergum VI of female with apical tooth at each side small and hidden in the dense hairs (Fig. 2).

This genus is known from Chile, Argentina, and Peru. At least some species visit flowers of Cactaceae for pollen. They range from very large (up to 21 mm long, *T. dubius* (Sichel)) to rather small (7 mm long, *T. colloncurensis* Ogloblin). The following species are placed in this genus: *albiceps* (Fries), 1908; *?alpestris* (Fries), 1923; *aterrimus* (Cockerell), 1926; *colloncurensis* Ogloblin, 1957; *dubius* (Sichel), 1867; *herbsti* (Fries), 1905 (= *muticus* (Herbst), 1918); *holomelan* (Moure), 1949; *laticeps* (Fries), 1906; *neoqueenensis* (Fries), 1910; *osmioides* (Fries), 1910; *pseudocellatus* (Moure), 1949; *shajovskoyi* Ogloblin, 1957; *wagenknechti* (Moure), 1949.

The name *Lithurgomma* was proposed for certain species in which there is a defined impunctate area in front of the anterior ocellus. The size and sharpness of definition of this area varies and intergradation to typical *Trichothurgus* thus seems to occur. Moreover, other features do not show close relationship among the forms having such an area. I therefore see no justification for recognition of *Lithurgomma* as a genus or even as a subgenus, a viewpoint supported by Snelling (in press).

Microthurge Michener, NEW GENUS (Figs. 4, 5, 8)

Type species: *Lithurgus pharcidontus* Moure.

Small, slender species having the form of a large *Heriades* or one of the small species of *Chelostomoides*; metasomal terga with apical pale hair bands. Facial prominence present in females, weakly so in some males, supraclypeal. Labrum as long as clypeus. Mandible with middle tooth longest. Maxillary palpus extremely short, 2-segmented; labial palpus 3-segmented (fourth segment absent). First flagellar segment less than twice as long as greatest width but over twice as long as second segment which is at least twice as broad as long. Tibiae, especially hindtibia, with shorter hairs on outer surface than on anterior and posterior surfaces and with strong spicules arranged as in *Lithurge*, present in males but more strongly developed in females. Arolia of male absent. Claws of female bifid. Hindbasitarsus of female about as long as tibia. Stigma larger than in other genera, sides basal to vein r diverging toward apex. Wing membrane with dense short hairs. Profile of first metasomal tergum as in *Lithurge*. Pygidial plate of female represented by flat upper surface of short apical spine of tergum VI; of male a

broad triangle, nearly pointed apically, not or but little extending beyond rest of tergum VII. Tergum VI of female with strong apical, marginal tooth at each side, not hidden in dense hairs.

Distribution.—This genus occurs in Argentina, Bolivia, and probably southern Brazil. The following species are included: *boharti* new species, *pharcidontus* (Moure), 1948; *pygmaeus* (Fries), 1908; and probably *corumbae* (Cockerell), 1901.

Discussion.—*Microthurge* is more similar to *Lithurge* than to *Trichothurgus*, as shown by the labral size, the large median mandibular tooth of both sexes, the tibial vestiture and spiculation, the densely hairy wings, the profile of the first tergum, and the apical spine and sublateral apical teeth of tergum VI of the female. It differs not only from *Lithurge* but also from *Trichothurgus*, however, by its small, slender form, the short two-segmented maxillary palpus, the cleft claws of the female, the larger pterostigma, the short apical spine of tergum VI of the female, and the broad rather than apically produced pygidial plate of the male. From other Western Hemisphere Lithurginae (except the possibly adventive *Lithurge huberi* Ducke), *Microthurge* differs by the lack of arolia in the male.

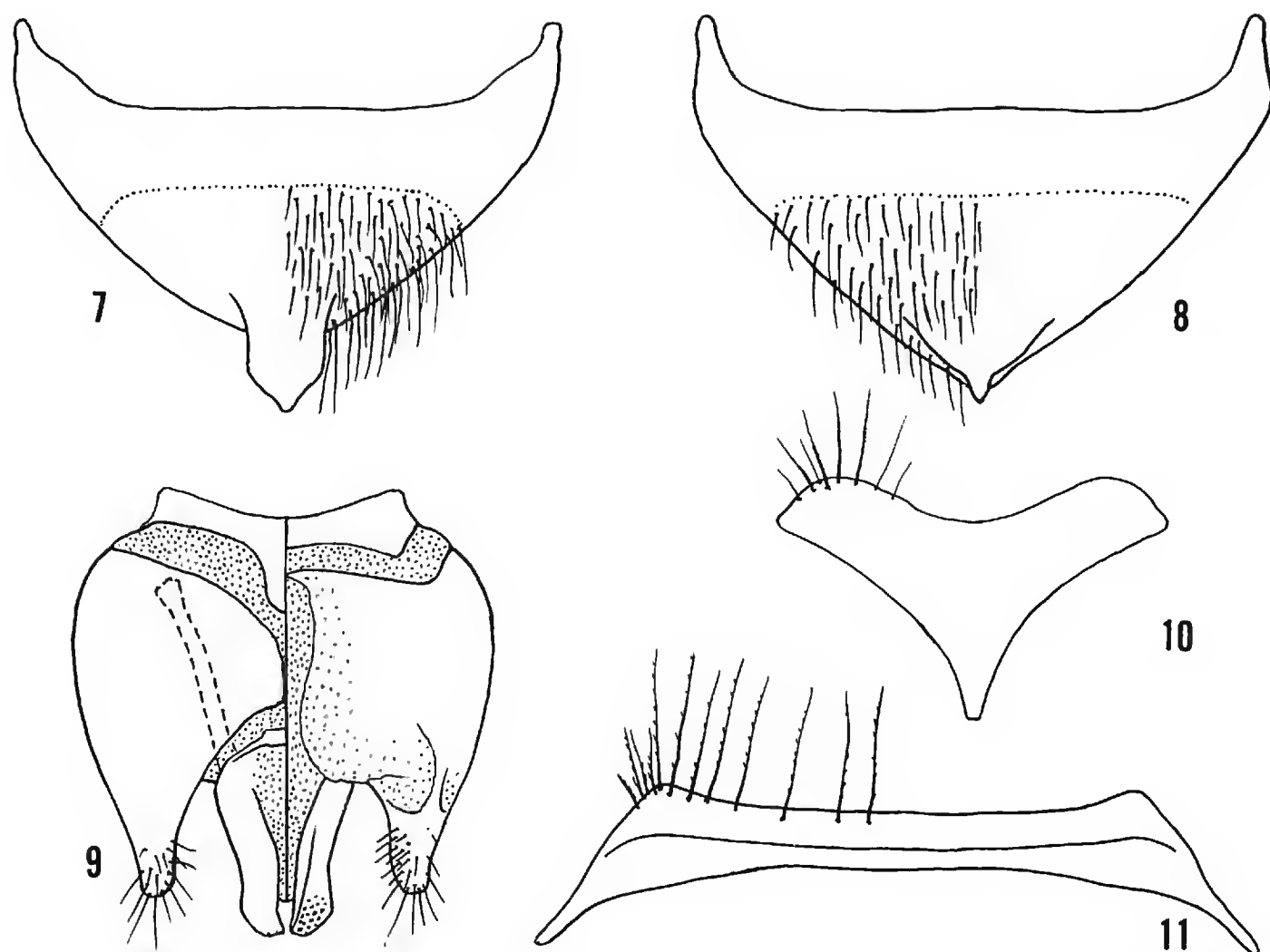
Etymology.—The generic name, formed in the manner of Padre J. S. Moure in naming *Trichothurgus*, is from *micro*, small, plus part of the generic name *Lithurge*.

Genus *Lithurge* Latreille

(Figs. 3, 6, 7, 9–11)

Robust but with metasoma somewhat flattened, commonly with hair bands. Facial prominence almost always present in females, absent in most males (present in males of *L. fortis*, etc.). Epistomal suture present or absent in females between tentorial pits. Labrum about as long as clypeus. Mandible with middle tooth longest. Maxillary palpus 3- to 4-segmented; labial palpus 4-segmented except in certain Old World species that lack fourth segment. First and second flagellar segments variable. Tibiae, especially posterior one, with hairs shorter on outer surface than on posterior surface. Fore and middle tibiae in female each with two longitudinal rows of coarse spicules extending basad on posterior part of outer surface from each of the two apical tibial spines, these rows outlining a channel on each tibia between rows which extends to the middle of the tibia or beyond nearly to base; sometimes some spicules between the rows; in male spicules smaller, rows shorter, sometimes absent. Hindtibia of female with coarse spicules scattered over short-haired outer surface; spicules smaller in males, absent in many species, present but small in *Lithurgopsis*. Arolia of male present or absent. Claws of female simple. Hindbasitarsus of female slightly shorter than to longer than tibia. Stigma small, sides basal to vein r parallel or nearly so. Wing membrane hairy, often densely so. Profile of first metasomal tergum with dorsal surface almost a direct continuation in a straight line from surface of basal concavity. Pygidial plate of female a flat or concave dorsal surface of long apical spine of tergum VI; of male a dorsally concave, broad, blunt projection or robust spine. Tergum VI of female with strong apical, marginal tooth at each side, not hidden in dense hairs; pygidial plate of male a broad flat-topped apical pointed projection.

This genus is world-wide in distribution in tropical and warm to moderate



Figs. 7-11. 7, 8, seventh metasomal terga of males; 7, *Lithurge apicalis* and 8, *Microthurge pharacidontus*. 9-11, *Lithurge apicalis*, male; 9, genitalia (dorsal side on left), 10, eighth sternum, 11, seventh sternum.

temperate zones, except that in the Americas it may be largely absent from the wet tropics. Two subgenera are commonly recognized, as follows.

Subgenus *Lithurge* Latreille, s. str.

Lithurge Latreille, 1825:463. Type species: *Andrena cornuta* Fabricius (monobasic).

Lithurgus Berthold, 1827:467. An emendation of *Lithurge*, hence type species automatically the same.

Arolia absent or rudimentary in both sexes (see Cockerell, 1905) except for *L. rubricatus* (from Australia) in which arolia of the male are as large and long as in male *Lithurgopsis*. Facial prominence of female involving upper part of clypeus and usually also part of supraclypeal area. First flagellar segment about twice as long as broad, more than twice as long as second, which is much broader than long.

This subgenus is found in Eurasia, Africa, Australia and intervening islands and includes all of the Old World species of the genus. In Africa it reaches the Cape, in Australia, New South Wales but is apparently absent from southern parts of the continent, while in Eurasia it extends north to Japan, China, Hungary, Spain, etc. To the east it occurs as far as Tahiti, perhaps having been carried by

primitive boats. One species, *L. huberi* Ducke, occurs in Brazil; it is probably the same as one of the Old World species and adventive in Brazil (Snelling, in press). Another species, *L. chrysurus* Fonscolombe, has been recorded by Roberts (1978) as introduced presumably from the Mediterranean region into New Jersey.

L. rubricatus Smith does not agree with *Lithurgopsis* except in the presence of long arolia in the male. Such arolia may be a primitive feature that survived in Australia and the Americas while being replaced in the rest of the world by forms lacking such arolia in both sexes.

While some species of this subgenus collect pollen from Malvaceae which have coarse pollen like that of the Cactaceae used by the subgenus *Lithurgopsis*, other species collect fine pollen of Compositae and perhaps other flowers. There may be morphological correlates with the type of flowers visited for pollen. Thus most species have coarse (malvaceous?) pollen on them and have the proboscis long, with the fourth segment of the labial palpus present. A few species have fine (composite?) pollen on them and have the proboscis shorter, with the fourth segment of the labial palpus absent. Such species are *L. chrysurus* Fonscolombe, *capensis* Friese (= *ovatus* Cameron), and *fuscipennis* Lepeletier.

Latreille's original spelling (1825) of the genus and subgenus name has been used here, although it has been regarded by many authors as French vernacular (e.g., Fox, 1902). Such authors use the emended Latinized form *Lithurgus*, introduced by Berthold (1827) when he translated Latreille's work into German. The spelling *Lithurge*, as noted by Fox (1902), was used by Lepeletier (1828:795) but by few subsequent authors. However, it was shown as the correct name by Sandhouse (1943) in her treatment of apoid generic names, and has since been used by Michener (1944, 1951) and Hurd (1979) in major studies and catalogues, as well as in shorter papers by various authors.

Subgenus *Lithurgopsis* Fox

Lithurgus (*Lithurgopsis*) Fox, 1902:138. Type species: *Lithurgus apicalis* Cresson (original designation).

Male with arolia. Facial prominence of female entirely supraclypeal (absent in one species being described by Snelling, in press). First flagellar segment not or little longer than broad, slightly longer than to shorter than second, which is nearly as long as broad to longer than broad.

This subgenus is limited to the Western Hemisphere, where it ranges from South Dakota to Argentina, but is absent from broad areas in the tropics. It collects pollen from Cactaceae. Snelling (in press) has reviewed the North American species.

APPENDIX

Below I establish a lectotype for a name in *Trichothurgus*, and present descriptions of the species of *Microthurge* available to me.

Trichothurgus herbsti (Friese)

Moure (1949) apparently correctly placed *Lithurgus muticus* Herbst, 1918, in the synonymy of "*Megachile*" *herbsti* Friese, 1905. Two males and two females of *Lithurgus muticus* Herbst are in the Museum of Comparative Zoology, Harvard

University, and evidently are cotypes, no holotype or lectotype having been designated. All are labelled Chile, Rio Blanco, P. Herbst; one female XII-10-17, one male and one female XII-11-17, and one male XII-26-17. The females and the male taken on XII-10 all bear the label "in floribus *Echinocactus ceratites* Otto," while the remaining male, probably taken on another flower, is labelled "Herbarium No. 46." Each also bears Herbst's label "*Lithurgus muticus* P. Herbst, Type" (the sex also being indicated on this label) and a red label "MCZ Type 17207." Herbst described the female first and in greater detail than the male; I therefore designate and have labelled the female taken on XII-10 as the lectotype.

***Microthurge pygmaeus* (Fries), NEW COMBINATION**

Lithurgus pygmaea Fries, 1908:62.

Female.—Upper margin of base of mandible just below lateral part of anterior clypeal margin with large, dorsoventrally flattened projection extending antero-ventrally (projection described as clypeal by Fries, 1908); apex of facial protuberance a transverse, shining carina over one third as long as width of face at that level and much nearer to antennal bases than is anterior ocellus; mesoscutum punctate, finely and closely so around margins, somewhat more coarsely and less closely so on disc.

Male.—Upper margin of clypeus with interspaces between punctures broader than elsewhere, forming a shining transverse band, sometimes weak; supraclypeal area slightly elevated and with a small tubercle on each side; shiny transverse basal zone of labrum uniform in convexity.

This species was described from Mendoza and is widespread in Argentina, as indicated by the following collecting data from specimens in the Snow Entomological Museum, University of Kansas. *Buenos Aires Prov.*: Villa Elias, Feb., 1955 (J. Foerster); Ing. R. Otamendi, Nov., 1954 (F. H. Walz); Tigre, Nov. 3-10, 1956; Dique, Luján, Nov., 1954 (F. H. Walz). *Entre Ríos Prov.*: Villaguay, Nov. 20, 1951 (J. Foerster). *Misiones Prov.*: Obera, Oct. 17, 1950 (M. Senkute). *Tucumán Prov.*: 20 km W. of S. M. de Tucumán, Dec. 10, 1971 (D. J. Brothers).

***Microthurge pharcidontus* (Moure), NEW COMBINATION**

Lithurgus pharcidontus Moure, 1948:321.

Female.—Mandibular projection absent; apex of facial protuberance shining, transverse, slightly emarginate medially seen from above, less than one third as wide as face at that level, almost as far below antennal bases as median ocellus is above; mesoscutum finely and closely punctate around margins, but broad median transverse zone between tegulae coarsely, transversely rugosopunctate, several transverse rugae particularly strong.

Male.—Unknown (see below).

This species was described from Tarancas, San Pedro de Colalao, Tucumán Prov., Argentina. Specimens from that locality, collected in December and February by P. J. M. Arnau and J. Foerster, are at hand. Additional specimens are from: ARGENTINA: *Tucumán Prov.*: El Cadillal; Oct., 1951 (J. Foerster). BOLIVIA: *Cochabamba Prov.*: Feb., 1952 (F. H. Walz).

A male that might be this species is from Guayaramerin, El Beni, Bolivia, Dec. 6, 1956 (M. Fritz). It is similar to that of *M. pygmaeus* but the upper part of the

clypeus is densely punctate; the shiny transverse basal zone of the labrum is distinctly prominent medially, not uniformly convex; the eyes, unlike those of other known species, are closer together below, separated by little more than the maximum ocular width; and the facial hairs are more golden.

Microthurge boharti Michener, NEW SPECIES

Female.—Length 8 mm (varying to 6 mm among paratypes); forewing length 6 mm (varying to 5 mm). Mandibular projection absent; apex of facial projection bilobed, shining laterally but punctate medially, less than one third as wide as face at that level, about two-thirds as far below antennal bases as median ocellus is above; mesoscutum similar to that of *M. pygmaeus* but disc slightly more coarsely and less closely punctate.

Male.—Length 7 mm, forewing length 6 mm. Upper margin of clypeus densely punctate like adjacent areas; supraclypeal area as described for *M. pygmaeus*; shiny transverse basal zone of labrum slightly prominent medially (sometimes only feebly so), not uniformly convex.

Types.—Holotype ♀, allotype ♂, and seven ♀ and one ♂ paratypes: ARGENTINA: *Cordoba Prov.*, Isla Martín García, Jan., 1943 (M. J. Viana). One ♀ paratype: *Cordoba Prov.*, Valle Hermoso (M. J. Viana). One ♂ and one ♀ paratype: *Cordoba Prov.*, Huerta Grande, Jan., 1941 (F. M. Walz). One ♀ paratype: labelled merely "Argentina." A series of specimens of both sexes in the Los Angeles County Museum of Natural History is from ARGENTINA, *Catamarca Prov.*, Andalgala, (J. L. Neff). Some or all were taken on flowers of *Abutilon virgatum* on March 14, 1973, and January 16, 1974. The holotype and allotype are in the Museo Argentina de Ciencias Naturales "Bernardino Rivadavia" (Buenos Aires), other type material is in the Snow Entomological Museum, University of Kansas.

Etymology.—*Microthurge boharti* is named in honor of R. M. Bohart.

Discussion.—This species could be *Microthurge corumbae* (Cockerell), **new combination**, the type of which I have not been able to locate. The description of *corumbae*, however, indicates a species with more abundant white hair and with the femora and first two metasomal segments dark ferruginous (Cockerell, 1901). These areas are black in *M. boharti*. Moreover, *M. corumbae* is from Corumbá, Mato Grosso, Brazil, which is in a moist tropical region, while *M. boharti* is from desertic areas farther south.

Micorthurge sp.?

Two small males (the smallest only 5 mm long) from Pocitos, Salta, Argentina, Nov. and Dec., 1956 (M. Fritz) may be conspecific with the male tentatively placed with *M. pharcidontus*. The supraclypeal area, however, lacks the two tubercles characteristic of that species.

ACKNOWLEDGMENTS

I am indebted to R. J. McGinley of the Museum of Comparative Zoology for the loan of lithurgine material, and to R. R. Snelling of the Los Angeles County Museum of Natural History not only for the loan of material but for sending me a copy of his unpublished paper on North American *Lithurge*.

This paper is a product of National Science Foundation grant DEB 77-23035.

LITERATURE CITED

- Berthold, A. A. 1827. Latreille's natürliche Familien des Thierreichs mit Anmerkungen und Zusätzen. Weimar, 8 + 602 pp.
- Cockerell, T. D. A. 1901. Descriptions of new bees collected by Mr. H. H. Smith in Brazil—II. Proc. Acad. Nat. Sci. Philadelphia 53:216-222.
- . 1905. Notes on some bees in the British Museum. Trans. Amer. Ent. Soc. 31:309-364.
- Fox, W. J. 1902. *Lithurgopsis*, a new genus of bees. Ent. News 13:137-140.
- Friese, H. 1908. Die Apidae (Blumenwespen) von Argentina nach den Reisenresultaten der Herren A. C. Jensen-Haarup und P. Jorgensen in den Jahren 1904-1907. Flora og Fauna 10:1-94.
- Hurd, P. D. 1979. Apoidea, pp. 1741-2209. In: K. V. Krombein, P. D. Hurd, D. R. Smith, and B. D. Burks, Catalog of Hymenoptera in America north of Mexico, vol. 2. Smithsonian Institution Press, Washington, D.C.
- Latreille, P. A. 1825. Familles naturelles du regne animal Paris, 570 pp.
- Lepeletier de St. Fargeau, A. [1828]. Encyclopedie Methodique. Insectes, vol. 10, pp. 345-832. Paris.
- Michener, C. D. 1944. Comparative external morphology, phylogeny, and a classification of the bees. Bull. Amer. Mus. Nat. Hist. 82:151-326.
- . 1951. Megachilidae, pp. 1136-1186. In: C. F. W. Muesebeck, K. V. Krombein, and H. Townes, Hymenoptera of America north of Mexico. Synoptic Catalog. U.S. Dept. Agric., Agric. Monog. 2.
- Moure, J. S. 1948. Notas sobre algunas abejas de Tacanas, Tucumán, Argentina. Rev. Ent. 19: 313-346.
- . 1949. Las especies chilenas de la sub-familia Lithurginae. Arq. Mus. Paranaense 7:265-286.
- Peters, D. S. 1972. Über die Stellung von *Aspidosmia* Brauns 1926 nebst allgemeinen Erörterungen der phylogenetischen Systematik der Megachilidae. Apidologie 3:167-186.
- Roberts, R. B. 1978. The nesting biology, behavior and immature stages of *Lithurge chrysurus*, an adventitious wood-boring bee in New Jersey. J. Kansas Ent. Soc. 51:735-745.
- Rozen, J. G., Jr. 1977. The ethology and systematic relationships of fideiine bees, including a description of the mature larva of *Parafidelia*. Amer. Mus. Novitates no. 2637:1-15.
- Sandhouse, G. A. 1943. The type species of the genera and subgenera of bees. Proc. U.S. Natl. Mus. 92:519-619.
- Snelling, R. (In press) The North American species of the bee genus *Lithurge*.

**Key to North and Central American Species of the Mealybug
Genus *Hypogeococcus* (Homoptera: Coccoidea: Pseudococcidae)
with Descriptions of Four New Species and
Redescription of the Type Species**

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I wish to express my gratitude to Dick and Margaret Bohart for their unselfish efforts in my behalf while I attended the University of California at Davis. I take great pleasure in dedicating this article to them as a token of my sincere appreciation for their guidance, example, and many kindnesses.

INTRODUCTION

The genus *Hypogeococcus* was described by George Rau in 1938 and included only *H. barbarae* Rau. Ferris (1953) included a second species, and later three more were added to the genus (Miller and McKenzie, 1971; Williams, 1973; Willink, 1981). In this paper four additional species are described, and the type species is redescribed.

Hypogeococcus is known in the New World only and occurs from New York to Argentina. Species have been collected on such diverse hosts as composites, cacti, orchids, and the unusual monocotyledonous genus *Eriocaulon*. Several species are of economic importance: *Hypogeococcus boharti* n. sp., *H. gilli* n. sp., *H. othnius* Miller and McKenzie, and *H. spinosus* Ferris often are encountered at ports-of-entry in the United States and are excluded from the U.S. because they are considered to be potential pests of cacti and orchids. *Hypogeococcus festerianus* (Lizer y Trelles) was introduced into Queensland, Australia as a biological control agent of the weedy cactus *Eriocereus martinii*. McFayden (1979) reported that the mealybug causes deformed and distorted growth to the cactus, and growth and seed development are greatly reduced. McFayden and Tomley (1978) predicted that successful biological control of the cactus in Australia likely would be achieved by the mealybug in combination with an introduced cerambycid.

MATERIALS AND METHODS

Although all specimens in the type series of the new species were examined in detail, a total of 10 specimens was used to determine ranges and means. The 10 specimens were selected from as many localities and hosts as possible. Averages were rounded off to the nearest whole number or to the nearest tenth of a micron. Specific geographic localities are not always given because many collections were taken at U.S. ports-of-entry and specific data are unknown. Specimens were studied using a Zeiss, phase contrast compound microscope at magnifications of 160, 400, and 1000 $\times$.

Terminology is the same as that used by Miller (1975) with the exception of abdominal segmentation of the female. I have followed the numbering system

adopted by Beardsley (1965), with the first visible abdominal segment numbered I. This system, unlike the one used by Ferris (1950), is consistent with the segmentation of the males (Theron, 1958). The term cisanal seta is applied to all of the setae on the venter of segment IX not just the posterior setae as suggested by Ezzat and McConnell (1956) and MacGillivray (1921). This was done to avoid giving each seta on this segment a separate name.

Depositories of types and their abbreviations are as follows: Auburn University, Auburn, Alabama (AUA); British Museum (Natural History), London (BMNH); California Department of Food and Agriculture, Sacramento (CDAS); Florida State Collection of Arthropods, Gainesville (FSCA); Institute of Zoology, Academia Sinica, Beijing, People's Republic of China (IZAS); Museo de Historia Natural de la Ciudad de Mexico, Mexico, D.F. (MCM); Museum National d'Histoire Naturelle, Paris (MNHP); Shanghai Institute of Entomology, Academia Sinica, People's Republic of China (SIE); University of California, Davis (UCD); University of Georgia, Experiment (UG); University of Hawaii at Manoa, Honolulu (UH); United States National Museum of Natural History, Washington, D.C. (USNM); Virginia Polytechnic Institute and State University, Blacksburg (VPI); and Zoological Institute, Academy of Sciences of USSR, Leningrad (ZIL).

Hypogeococcus Rau

Hypogeococcus Rau, 1938:159. Type species: *Hypogeococcus barbarae* Rau, 1938, by monotypy.

Diagnosis of adult females.—Dorsomedial setae on posterior abdominal segments enlarged, often conical, similar to cerarian setae; without trilocular pores; cerarii on abdomen only, with 4–6 pairs; posterior cerarii each with more than 2 conical setae; circulus small and oval, not divided; unusually large anal ring for pseudococcid.

Notes.—No single character can be used to distinguish species of *Hypogeococcus* from all other pseudococcid genera. Members of the genus can be separated by use of a combination of the above mentioned characters; individual species possess a majority but not all of these diagnostic features. In fact, the character states mentioned in the diagnosis are absent on one or more of the included species.

As in previous studies (Ferris, 1953; Miller and McKenzie, 1971), the monophyletic nature of *Hypogeococcus* remains questionable. There appear to be several groups of species within the confines of what currently is considered to be *Hypogeococcus*. These are: 1. *boharti* and *othnius* (without trilocular pores and dorsomedial conical setae, translucent pores absent from hind coxa, anal ring with 2 or 3 rows of pores, first instar with triloculars only and more than 2 cerarii, on orchids); 2. *festerianus*, *pungens*, and *spinosus* (without trilocular pores, dorsomedial conical setae abundant on posterior 4 or 5 abdominal segments, anal ring broad with 2 or 3 rows of pores, translucent pores on hind coxa, first instar with triloculars and 1 or 2 pairs of cerarii, primarily on cactus); 3. *hamoni* and *margaretae* (without trilocular pores, dorsomedial conical setae uncommon on posterior 4 or 5 abdominal segments, anal ring broad, with 6–8 rows of pores, translucent pores on hind coxa, first instar with triloculars and more than 2 pairs of cerarii, on *Eriocaulon*); 4. *barbarae* (with trilocular pores, dorsomedial conical setae abundant on posterior 4 or 5 abdominal segments, anal ring narrow with 2

rows of pores, translucent pores on hind coxa, first instar unknown, on Compositae); 5. *gilli* (with trilocular pores, dorsomedial conical setae abundant on posterior 4 or 5 abdominal segments, anal ring broad with 4 or 5 rows of pores, translucent pores on hind coxa, first instar unknown, on orchids).

Groups 2 and 3 each possess enlarged leg setae, and the basal segment of the labium is closely appressed to the second segment. These characters, which probably are synapomorphies, may suggest a close relationship between these groups.

Douglas J. Williams, Commonwealth Institute of Entomology, London, England and Christina Grana de Willink, Universidad Nacional de Tucuman, Argentina, are continuing their studies of South American species of the genus. According to Doug Williams (pers. corresp.) several problems remain unresolved in regard to the Argentine species. I hesitate to instigate any generic rearrangements until these problems are resolved, until more species are described, and until first instars and adult males have been studied more completely.

Hypogeococcus contains the following species:

1. *barbarae* Rau, 1938:159 (New York) (Compositae).
2. *boharti* Miller, n. sp. (Central America, Mexico) (Orchidaceae).
3. *festerianus* (Lizer y Trelles), 1942:24 (Argentina) (Cactaceae) (see Williams, 1973).
4. *gilli* Miller, n. sp. (Costa Rica) (Orchidaceae).
5. *hamoni* Miller, n. sp., (Florida) (*Eriocaulon*-Eriocaulaceae).
6. *margaretae* Miller, n. sp. (Florida) (*Eriocaulon*-Eriocaulaceae).
7. *othnius* Miller and McKenzie, 1971:578 (Central America, northern South America, Mexico) (Orchidaceae).
8. *pungens* Willink, 1981:61 (Argentina) (*Alternanthera*-Polygonaceae).
9. *spinus* Ferris, 1953:382 (California, Texas) (Cactaceae).

Pseudococcus mirabilis Brain (1915), an African species, was placed in *Hypogeococcus* by De Lotto (1974). It is clear that *mirabilis* does not belong in the latter genus since it has only slightly enlarged dorsomedial setae, has trilocular pores, has only 2 conical setae in each posterior cerarius, lacks a circulus, and has a narrow, weakly developed anal ring.

KEY TO ADULT FEMALES OF *HYPOGEOCOCCUS* FROM NORTH AND CENTRAL AMERICA

- | | | |
|------|--|---|
| 1. | Trilocular pores present | 2 |
| – | Trilocular pores absent | 3 |
| 2(1) | Oral-collar tubular ducts absent from medial area of dorsum; dorsal area of posterior abdominal segment sclerotized throughout; without a circulus | 2 |
| – | Oral-collar tubular ducts present over dorsal surface; dorsal area of posterior abdominal segment with sclerotization restricted to cerarian area; usually with a circulus | 3 |
| 3(2) | Without conical or enlarged setae on dorsomedial areas of segments VI and VII, these areas with bristle-shaped setae only | 4 |
| – | At least 1 conical or enlarged seta on dorsomedial areas of either or both of segments VI and VII | 5 |
| 4(3) | Posterior 4 pairs of cerarii each with 3 or more conical setae | 5 |
| | <i>boharti</i> Miller, n. sp. | |

- Posterior 4 pairs of cerarii each with 2 conical setae *othnius* Miller and McKenzie
- 5(3) Oral-collar tubular ducts on dorsomedial areas of thorax ... *spinosus* Ferris
- Oral-collar tubular ducts absent from dorsomedial areas of thorax ... 6
- 6(5) Femora of hind 2 pairs of legs with enlarged setae; dorsal setae predominately enlarged; antennae 5-segmented, occasionally with third segment partially divided; penultimate cerarius with same number or more conical setae than anal-lobe cerarius *margaretae* Miller, n. sp.
- Femora of hind 2 pairs of legs without enlarged setae; dorsal setae predominately unenlarged; antennae 6-segmented, or 7-segmented; penultimate cerarius with fewer conical setae than anal-lobe cerarius *hamoni* Miller, n. sp.

Hypogeococcus barbarae Rau

Hypogeococcus barbarae Rau, 1938:159; Ferris, 1953:380; McKenzie, 1967:201; Miller and McKenzie, 1971:578; Williams, 1973:567, De Lotto, 1974:109; Cruttwell and Fidalgo, 1974:1; McFadyen, 1979:284; Willink, 1981:61.

Etymology.—The species epithet was named in honor of Mrs. Barbara Rau, the mother of George Rau.

Type data.—In the original description Rau stated that the holotype was deposited in his private collection. I have been unable to locate Mr. Rau or his collection. None of the type series is part of the holdings of the American Museum of Natural History, Cornell University, or the New York State Museum, Albany. A single slide with data identical to that given by Rau in the original description has been located in the collection of the University of California at Davis. It is labelled in Rau's handwriting as follows: "Hypogeococcus/barbarae Rau/Aster sp./Saratoga Springs,/Sept. 11, 1936./Rau." The slide contains 3 specimens, and although no type designation is on the slide, it clearly is part of the paratype series. Two additional slides each containing 3 specimens are labelled in Ferris' handwriting; they probably are part of the type series, but they lack a specific date in September. Another slide from the type series is deposited in the collection of the British Museum (Natural History). It contains 2 specimens and was collected a year later; it is labelled in Rau's handwriting as follows: "Hypogeococcus/barbarae Rau/On Aster sp./Saratoga Springs,/N.Y. 8/6/37./Paratypes/Rau." Rau apparently tried to recollect the species again in 1938. Specimens collected at Saratoga Springs, on *Aster* sp., in June and late August are also in the collection at Davis, but these specimens are not *Hypogeococcus barbarae* and are not part of the type series. Three topotype specimens on 2 slides deposited in the U.S. National Museum are labelled as *Hypogeococcus barbarae*. These specimens were collected in late September 1936 and 1938 but are not *H. barbarae*; they are similar to species of *Humococcus* by virtue of the form of their anal ring, but their correct identity is uncertain.

ADULT FEMALE (4TH INSTAR) (Fig. 1)

This description is based on the 5 paratype specimens labelled by Rau and the 6 specimens labelled by Ferris mentioned above.

Description.—Mounted 0.9–1.4 (1.2) mm long, 0.6–0.8 (0.7) mm wide. Body elongate oval.

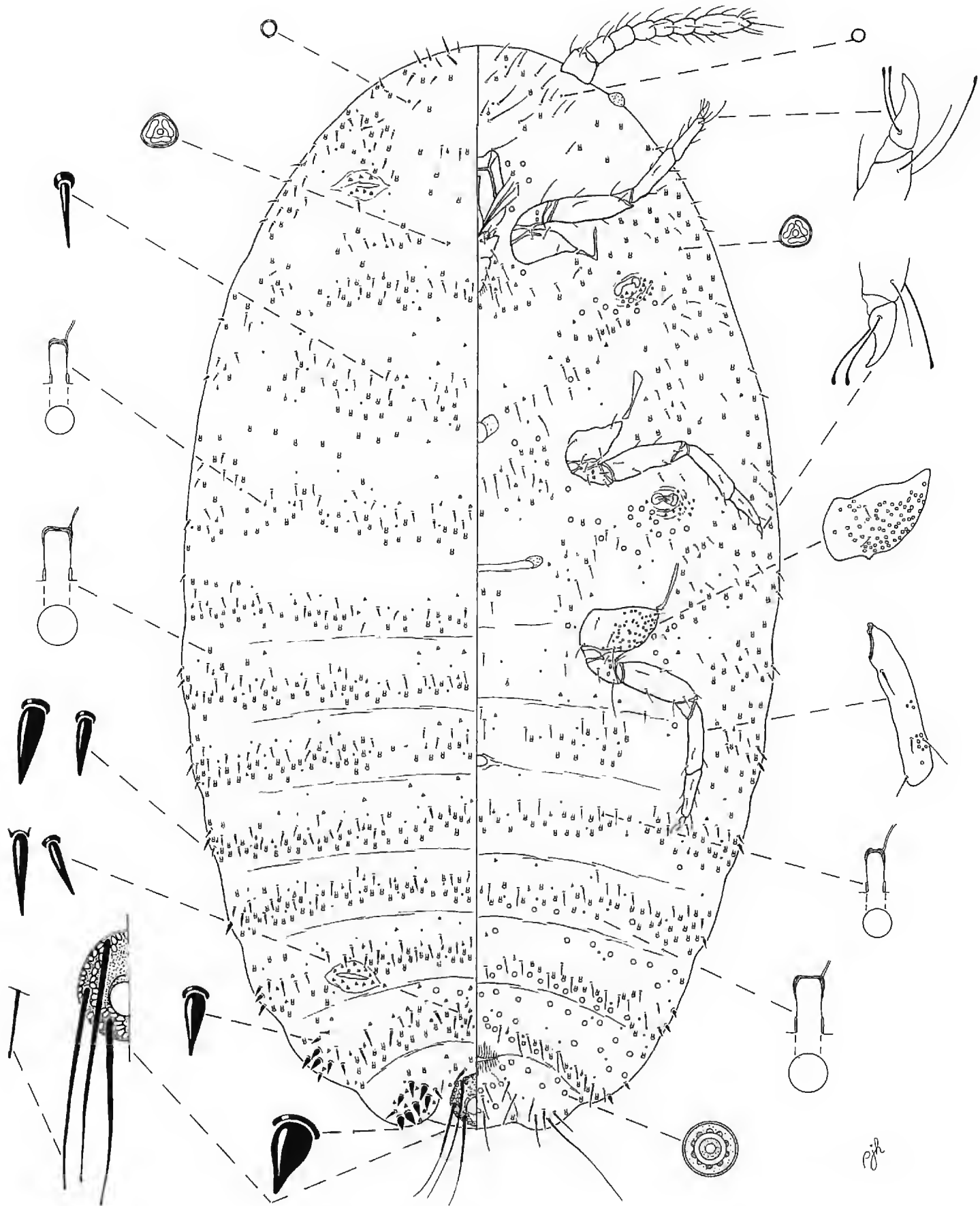


Fig. 1. Adult female paratype of *Hypogeococcus barbarae* Rau. Saratoga Springs, New York, IX-11-36, on *Aster* sp.

Dorsum with 4-6 (6) pairs of cerarii. Anal-lobe cerarius with little or no sclerotization, no bristle-shaped setae, 5-9 (7) conical setae, 5-12 (9) trilocular pores, 0-1 (0) discoidal pores. Penultimate cerarius with 4-9 (7) conical setae, small cluster of trilocular pores. Antepenultimate cerarius with 3-7 (5) conical setae, occasional basal trilocular pore. Fourth cerarius with 1-5 (3) conical setae, without basal trilocular pores. Fifth cerarius with 0-2 (2) conical setae, without associated

trilocular pores. Sixth cerarius with 0-2 (1) conical setae, without associated trilocular pores. With 2 kinds of setae; posterior setae conical, not as large as cerarian setae, gradually becoming thinner anteriorly; setae at juncture of thorax and abdomen thin, not bristle-shaped, present over remainder of abdomen; longest seta on segment VII, excluding those in surrounding cerarian cluster, 20-25 (22) μ long, segment IV with 30-41 (34) setae excluding those in cerarii. Trilocular and discoidal pores scattered over surface, discoidal pores less abundant. Multilocular pores absent from 1 of 11 specimens, when present, with 1-8 (4) pores on 1 or all of segments VI-VIII. Oral-collar tubular ducts of 2 distinct sizes, scattered over surface, without conspicuous collar. Ostioles obvious.

Anal ring on dorsal surface touching apex of abdomen, with 2 rows of pores; anal-ring setae with apex slightly rounded or swollen, longest seta 116-165 (135) μ long, longest seta 1.9-2.4 (2.1) times longer than greatest diameter of anal ring.

Venter with 1 kind of seta; bristle-shaped setae with longest seta on segment VII 27-37 (30) μ long; with 3 pairs of cisanal setae, longest seta 28-47 (37) μ long; longest anal-lobe seta 123-138 (131) μ long; length of longest anal-ring seta/length of longest anal-lobe seta 0.8-1.2 (1.0). Multilocular pores in medial areas near anterior margin of segments VI or VII-IX, in medial areas near posterior margin of segments III, IV, or V-IX, in lateral areas on each abdominal segment rare or absent on III and/or II, multilocular pores present on thorax in clusters surrounding mouthparts, spiracles, and legs. Trilocular and discoidal pores scattered over surface. Oral-collar tubular ducts of same 2 sizes as on dorsum, present over surface. Ventral anal lobe weakly sclerotized.

Circulus absent from 4 of 11 specimens, when present, transversely oval, width/length 1.0-1.7 (1.3), 12-37 (28) μ wide. Hind legs with 42-112 (79) translucent pores on dorsal surface of hind coxa, 49-86 (66) on ventral surface; with 3 translucent pores on 1 femur of 1 specimen, absent from femora of remaining specimens; hind tibiae with translucent pores on 9 of 10 specimens, when present, with 4-17 (8) pores arranged in 2 clusters on dorsal surface. Hind femora 101-114 (108) μ long; tibiae 73-91 (84) μ long; tarsi 52-62 (57) μ long; length of femur/tibia 1.2-1.5 (1.3); length of tibia/tarsus 1.4-1.6 (1.5). Tibiae with 5-7 (6) setae, those on lateral surface (as drawn) very small. Leg setae bristle shaped; digitules usually broken, tarsal digitules apparently reaching tip of claw, digitules of all 3 pairs of legs each apparently with 1 thick seta with capitate apex and 1 thin seta with acute apex; claw digitules extending beyond apex of claw, with conspicuous club, about equal in size. Antennae 7-segmented, 168-217 (200) μ long, with bristle-shaped setae. Labium with basal segment separate, 67-81 (74) μ long. Eye without associated discoidal pores.

Comparison.—Adult females of *Hypogeococcus barbarae* and *H. gilli* superficially are similar by having trilocular pores. In addition to the characters used in the key, *H. barbarae* differs by having the anal-lobe cerarius with 5-9 (7) conical setae, 5-12 (9) trilocular pores, and 0-1 (0) discoidal pores, by having dorsal multilocular pores absent or present in the dorsomedial areas of the posterior abdominal segments, 2 distinct sizes of oral-collar tubular ducts, longest anal-ring seta 116-165 (135) μ long, 3 pairs of cisanal setae, longest anal-lobe seta 123-138 (131) μ long, multilocular pores present around mouthparts, hind coxae with 42-112 (79) translucent pores on the dorsal surface, hind tarsi each 52-62 (57) μ long, hind tibiae each with 5-7 (6) setae, antennae each 168-217 (200) μ long.

Hypogeococcus gilli has the anal-lobe cerarii each with 9–14 (12) conical setae, 17–21 (19) trilocular pores, and 1–3 (2) discoidal pores, has the dorsal multilocular pores absent from the medial areas, 1 size of oral-collar tubular duct, longest anal-ring seta 205–217 (213) μ long, 2 pairs of cisanal setae, longest anal-lobe seta 163–187 (177) μ long, multilocular pores absent from area around mouthparts, hind coxae each with 15–21 (18) translucent pores on the dorsal surface, hind tarsi each 87–103 (97) μ long, hind tibiae each with 9–10 (9) setae, antennae each 246–273 (256) μ long.

***Hypogeococcus boharti* Miller, NEW SPECIES**

Etymology.—The species epithet is given in recognition of the many scientific accomplishments of Dr. Richard M. Bohart and of the many hours that he spent teaching me about insect systematics. Dick's never ending enthusiasm and energy for acquiring new knowledge about the taxonomy of insects has been an important inspiration to my career as a systematist.

Although most know him as an authority of the Hymenoptera, he also has contributed to the field of coccidology. In 1942 he published a paper on the life history of the armored-scale pest *Diaspis boisduvalii* Signoret, and it remains the most important work on the biology of the species. In 1958 he collected an undescribed species of mealybug that later was named in his honor (*Rhizoecus boharti* McKenzie) by McKenzie (1960). It was through Dick Bohart's administrative efforts that Howard L. McKenzie was hired at the University of California at Davis and the Gordon F. Ferris collection of scale insects was obtained and incorporated in the Entomology Department's Collection. Dick's encouragement and advice had major impact on the highly productive, later years of Howard McKenzie's research career. Therefore, this species is named in honor of Dick Bohart for his several contributions to the field of scale-insect systematics. It seems especially appropriate that the epithet "boharti" be given to this orchid infesting species since his 1942 paper was about a pest of *Cattleya* orchids.

Type data.—Holotype adult ♀, right specimens of 3 on slide, with left label "Hypogeococcus/DRAW/On Orchidaceae/leaf Mexico/(Coyutla Vera Cruz)/at Hidalgo 1359 I-1-1974 75-6363/D. R. Riley colr."; right label has a map showing position of holotype and "Hypogeococcus/boharti/Miller/HOLOTYPE" (USNM). In addition to the holotype there are 44 paratype specimens on 22 slides. The paratype data are as follows: BELIZE—On orchid, III-6-70, J. C. Buff. CANAL ZONE—On orchid, IV-7-75, H. L. Rubin. EL SALVADOR—On *Oncidium ornithorhynchum*, II-25-69, B. E. Davis, A. J. Benton. GUATEMALA—On *Oncidium cristagolli*, VI-10-65, R. Reasoner; on orchid, V-30-80, F. Matthews. HONDURAS—On orchid, III-7-77, W. Forster; on orchid, I-5-81, J. Torres; on orchid, VIII-26-81, F. Matthews; on *Oncidium* sp., II-18-75, F. Matthews; on Orchidaceae, VII-31-68, L. R. Gillogly. MEXICO—On *Odontoglossum bicto-niense*, VI-18-73, G. L. Piro; on orchid, V-21-51, Cary; on *Sobralia* sp., III-29-38, R. H. Buffham; Coyutla, on Orchidaceae, I-1-74, D. R. Riley; Oaxaca, on orchids, XII-6-65, L. R. Gillogly; Vera Cruz, on *Coffea arabica*, II-1-67, G. K. Browne; Vera Cruz, on orchid, I-1-74, D. R. Riley. Paratype slides have been deposited in BMNH, CDAS, FSCA, MCM, MNHP, UCD, UG, UH, USNM, VPI, and ZIL.

ADULT FEMALE (4TH INSTAR)
(Fig. 2)

Description.—Holotype mounted, 1.5 mm long (paratypes 1.6–2.7 (2.0) mm), 0.7 mm wide (paratypes 0.8–1.6 (1.1) mm). Body elongate oval.

Dorsum with 5 and 6 pairs of cerarii (paratypes with 5–7 (6) cerarii). Anal-lobe cerarius, including ventral area with conical setae, with basal sclerotization, 7 bristle-shaped setae, 9 and 8 conical setae, 6 multilocular pores, 3 discoidal pores (paratypes with 5–7 (6) bristle-shaped setae, 3–9 (7) conical setae, 1–6 (4) multilocular pores, 1–5 (3) discoidal pores). Penultimate cerarius with basal sclerotization, 11 conical setae (paratypes with 7–14 (10) conical setae) and several bristle-shaped setae, oral-collar tubular ducts, multilocular and discoidal pores. Antepenultimate cerarius with slight basal sclerotization, 7 and 8 conical setae (paratypes with 5–11 (8) conical setae), and 1 or more bristle-shaped setae, oral-collar tubular ducts, multilocular and discoidal pores. Fourth cerarius with or without weak basal sclerotization, 6 and 7 conical setae (paratypes with 3–7 (6) conical setae), and 1 or more oral-collar tubular ducts and discoidal pores. Fifth cerarius with 4 and 5 conical setae (paratypes with 3–7 (4) conical setae), and 1 or more oral-collar tubular ducts and discoidal pores. Sixth cerarius absent on 1 side with 2 conical setae on other (paratypes with 0–3 (2) conical setae) and 1 or more discoidal pores. Seventh cerarius absent (present on 6 of 10 paratypes, with 0–3 (1) conical setae). With 1 kind of seta; bristle-shaped setae longer posteriorly; longest seta on segment VII, excluding those surrounding cerarian cluster, 55 μ long (paratypes 47–75 (57) μ); segment IV with 33 setae, excluding those in cerarii (paratypes with 27–35 (31) setae). Trilocular pores absent. Discoidal pores scattered over surface; small, irregular sclerotized spots also scattered over surface. Multilocular pores present over surface, least abundant near posterior apex. Oral-collar tubular ducts with inconspicuous collar, short, in marginal or submarginal areas of head to segment VII, in mediolateral areas of all segments except prothorax, mesothorax, and segment VIII (paratypes with oral collars absent from mediolateral areas of segment VIII and any or all of prothorax, mesothorax, metathorax, or segment I), in medial areas on all segments except segment VIII and prothorax to segment 2 (paratypes with medial oral collars absent from prothorax to segment I, II, III, or IV, and absent from segment VIII). Ostioles small.

Anal ring dorsal, touching apex of abdomen (3 of 10 paratypes with anal ring bent around posterior apex of abdomen), with 2 or 3 rows of pores; anal-ring setae with narrow, acute apices, largest seta 240 μ long (paratypes 215–245 (228) μ), longest seta 2.7 times longer than greatest diameter of ring (paratypes 2.3–3.1 (2.6) times).

Venter with bristle-shaped setae only, excluding setae in cerarii; with 3 pairs of cisanal setae, longest cisanal seta 40 μ long (paratypes 27–43 (38) μ); anal-lobe setae 157 and 153 μ long (paratypes 110–173 (138) μ); length of longest anal-ring seta/length of longest anal-lobe seta 1.5 (paratypes 1.3–2.0 (1.7) units). Multilocular pores scattered over surface except anterior margin of medial areas of segments I–VI (paratypes with multiloculars absent from anterior margin of segments I, II, or III to V or VI), posterior margin of medial areas of segments I–IV (paratypes

areas of segments IV-VI (paratypes with oral collars from II, III, or IV to VI or VII). Ventral anal-lobe area broadly sclerotized, with 1 or 2 conical setae, bristle-shaped setae, multilocular and discoidal pores.

Circulus nearly round, width/length 1.1 (paratypes 0.9-1.3 (1.0) units), 35 μ wide (paratypes 30-60 (40) μ). Hind legs with 35 and 29 translucent pores on dorsal surface of each femur arranged in cluster near distal apex of anterior margin (as drawn) and in cluster along posterior margin (paratypes with 13-35 (26) pores, occasionally without distal cluster); tibia with 27 and 48 pores on dorsal surface scattered along outer margin (as drawn) (paratypes with 26-42 (33) pores). Hind femora 155 and 153 μ long (paratypes 140-165 (151) μ); tibiae 107 and 113 μ long (paratypes 104-123 (112) μ); tarsi each 67 μ long (paratypes 61-73 (67) μ); length of femur/tibia 1.4 (paratypes 1.3-1.4 (1.3) units); length of tibia/tarsus 1.6 and 1.7 (paratypes 1.5-1.7 (1.7) units). Tibiae with 8 and 9 setae (paratypes with 9-10 (9) setae). Leg setae bristle shaped; tarsal digitules not quite reaching tip of claw, digitules of hind 2 pairs of legs approximately equal in length, 1 noticeably more slender than other including apical club, digitules of front legs unequal, 1 without apical club, other similar to digitules of hind tarsi; claw digitules extending beyond apex of claw, equal in size, slightly larger than largest tarsal digitule. Antennae 6- and 7-segmented (paratypes 6- and 7-(7-)segmented), 6-segmented antenna with third segment partially divided, 263 and 250 μ long (paratypes 245-310 (275) μ), with bristle-shaped setae. Labium with basal segment separate, 90 μ long (paratypes 93-113 (99) μ). Eye with 2 and 3 loosely associated discoidal pores (paratypes with 1-3 (2) pores).

THIRD-INSTAR FEMALE

(Fig. 3)

Description.—Mounted, 1.1 and 1.2 mm long, 0.5 and 0.6 mm wide. Body elongate.

Dorsum with 5-6 (5) pairs of cerarii. Anal-lobe cerarius, including ventral area with conical setae, with basal sclerotization, 2-3 (3) bristle-shaped setae, 4-5 (4) conical setae, 1-2 (1) multilocular pores, 0-1 (0) discoidal pores. Penultimate cerarius with basal sclerotization, 5-7 (6) conical setae, and 1 or more bristle-shaped setae, discoidal pore, and oral-collar tubular duct. Antepenultimate cerarius with slight basal sclerotization, 3-5 (4) conical setae. Fourth cerarius with or without weak basal sclerotization, 3-4 (3) conical setae. Fifth cerarius with 3-4 (3) conical setae. Sixth cerarius with 0-2 (1) conical seta. With 1 kind of seta; bristle-shaped setae longer posteriorly; longest seta on segment VII, excluding those surrounding cerarian cluster, 40 and 43 μ long; segment IV with 18 setae, excluding those in cerarii. Trilocular pores absent. Discoidal pores scattered over surface; small, irregular sclerotized spots also scattered over surface. Multilocular pores present over surface, least abundant medially. Oral-collar tubular ducts of same structure as on adult, in marginal and submarginal areas of head to segment VII, in mediolateral areas of all segments except prothorax to segment I and segment VIII, in medial areas of all except prothorax to segment III and segment VIII on 1 specimen, absent from medial area on other specimen. Ostioles small.

Anal ring bent around posterior apex of abdomen, with 2 rows of pores; anal-ring setae with acute apices, longest seta 145 and 170 μ long, longest seta 1.9 and 2.9 times longer than greatest diameter of ring.

same size and shape as on dorsum, on marginal and submarginal areas of head to segment VII in mediolateral areas of segment V on 1 specimen, V and VI on other, absent medially. Ventral anal-lobe area broadly sclerotized, with bristle-shaped setae, multilocular and discoidal pores.

Circulus nearly round width/length 1.1 and 1.3, 20 and 25 μ wide. Hind legs with traces of translucent pores on femora and tibiae (these pores may be from the legs of the adult before shedding). Hind femora 105–117 (110) μ long; tibiae 73–80 (76) μ long; tarsi 67–80 (68) μ long; length of femur/tibia 1.4–1.5 (1.4); length of tibia/tarsus 1.1. Tibiae with 9 setae. Leg setae bristle-shaped; digitules same as on adult. Antennae 6-segmented, 1 antenna with third segment partially divided, 203–230 (219) μ long, with bristle-shaped setae. Labium with basal segment separate, 75 and 73 μ long. Eye with 0–2 (1) loosely associated discoidal pores.

FIRST INSTAR

Specimens examined.—The following description is based on 42 embryos from the following 6 localities (complete data given under “Type Data”): Belize; Guatemala (1965 and 1980); Honduras (I-5-1981); Mexico (1938 and 1974).

Description.—Only salient features are included because of the poor condition of the available material.

Mounted 326–440 (391) μ long, 175–225 (198) μ wide. Body elongate.

Dorsum with 4–5 (4) pairs of cerarii that have at least 1 conical seta, with up to 14 paired, enlarged bristle-shaped setae along each body margin including those with conical setae; cerarii usually without associated pores, without basal sclerotization. Anal-lobe cerarii with 2 conical setae, 1 trilocular pore between cerarian setae; penultimate and antepenultimate cerarii each with 2 conical setae; fourth cerarii with 1–2 (1) conical setae, 0–1 (0) bristle-shaped setae; fifth cerarii with 0–1 (0) conical setae, 1–2 (2) bristle-shaped setae. With 1 kind of seta; bristle-shaped setae scattered over dorsum, arranged in 4 longitudinal lines on most of abdomen, shortest setae in center of body; longest seta on segment VII 17–27 (23) μ long, segment IV with 4 setae excluding those in cerarii. Trilocular pores scattered over surface, on abdomen usually with 1 pore between each cerarius and mediolateral seta, and 1 pore between each mediolateral seta and medial seta, located between anterior and posterior margin of each segment, forming 4 longitudinal lines of trilocular pores on abdomen. Discoidal and multilocular pores absent. Tubular ducts absent. Ostioles present.

Anal ring apical, with 2 rows of pores; anal-ring setae with acute apices, longest setae 54–73 (63) μ long.

Venter with 1 kind of seta, forming 6 longitudinal lines of setae on abdomen; bristle-shaped setae scattered over surface, longest seta 16–37 (25) μ long; longest anal-lobe seta 50–55 (52) μ long. Trilocular pores associated with submarginal and mediolateral lines of setae on abdomen. Multilocular pores absent. Discoidal pores associated with submarginal line of setae. Tubular ducts absent. Ventral anal-lobe area not sclerotized.

Circulus oval, not divided, 8–11 (10) μ wide. Legs unclear; tibia with 7–8 (7) setae; leg setae bristle shaped; tarsal digitules extending beyond tip of claw, digitules of hind 2 pairs of legs equal in length, 1 noticeably more slender than other, digitules of front legs unequal, 1 without apical club, other about same as larger

digitule on hind legs; claw digitules extending beyond tip of claw, 1 digitule slightly thinner than other. Antennae unclear. Labium details unclear. Eye with 1 associated discoidal pore.

Comparison.—Adult females of *H. boharti* and *H. othnius* are similar; both lack dorsomedial conical setae, have 2 or 3 rows of pores in the anal ring, have apices of the anal-ring setae slightly rounded or capitate, have the length of the longest anal-ring seta/the greatest diameter of the anal ring about 2.6, have the longest anal-ring seta about 220 μ long, have translucent pores on the femur and tibia, usually have a discoidal pore associated with the eye, and occur on orchids. *Hypogeococcus boharti* differs by having more than 2 conical setae in each of the posterior 4 pairs of cerarii, and circulus oval, rarely longer than wide; *H. othnius* has 2 conical setae in each of posterior 4 pairs of cerarii (1 specimen has 1 cerarius with 3 conical setae), and circulus elongate, usually longer than wide. The above mentioned species share several similarities with *H. gilli*; all have the apex of the anal-ring setae rounded or capitate, usually have 7-segmented antennae, and have 9 or 10 setae on each hind tibia. *Hypogeococcus gilli* is easily separated by having trilocular pores, by lacking a circulus, by having many pores near the base of the cerarian conical setae in the anal-lobe cerarius, and by having translucent pores on the hind coxa; *H. boharti* and *H. othnius* lack trilocular pores, have a circulus, lack pores near the base of the cerarian conical setae in the anal-lobe cerarius, lack translucent pores on the hind coxa.

A comparison of *H. boharti* and *H. margaretae* is given in the species treatment of the latter species.

Hypogeococcus gilli Miller, NEW SPECIES

Etymology.—The species epithet is named in honor of Mr. Raymond J. Gill, California Department of Food and Agriculture, Sacramento, not only for providing the type series of this species, but also for his dedication and many important contributions to the study of scale-insect systematics.

Type data.—Holotype adult ♀, single specimen on slide, with left label “*Hypogeococcus/gilli* Miller/HOLOTYPE/Det. by CDA/VII-62/C₄N₈O AF + LP-B.”; right label “sp. 13033/No. 62G20-55 Cal. Dept. Agr./Q. fr./Loc. Costa Rica at San/Pedro, California/17-VII-1962/ex. orchid leaf/Draw/J. Lindsay coll” (USNM). In addition, there are 2 adult female paratypes on 2 slides with the same data (CDAS and BMNH).

ADULT FEMALE (4TH INSTAR)

(Fig. 4)

Description.—Holotype, mounted, 1.7 mm long (paratypes 1.8 and 2.0 (1.9) mm) 0.8 mm wide (paratypes each 1.0 mm). Body elongate oval.

Dorsum with 5 pairs of cerarii, sixth pair reduced to single conical seta on 1 side of specimen, with 2 such setae on other side (1 paratype with definite sixth cerarius with basal sclerotization). Anal-lobe cerarius part of sclerotized plate on dorsum of segment VIII, with 11 conical setae, 17 trilocular pores, 2 discoidal pores (paratypes with 9–14 (12) conical setae, 17–21 (19) trilocular pores, and 1–3 (2) discoidal pores). Penultimate cerarius defined by basal sclerotization extending on to ventral surface with 11 and 12 conical setae with 2 larger than others (paratypes with 11–18 (14) conical setae), with cluster of basal trilocular

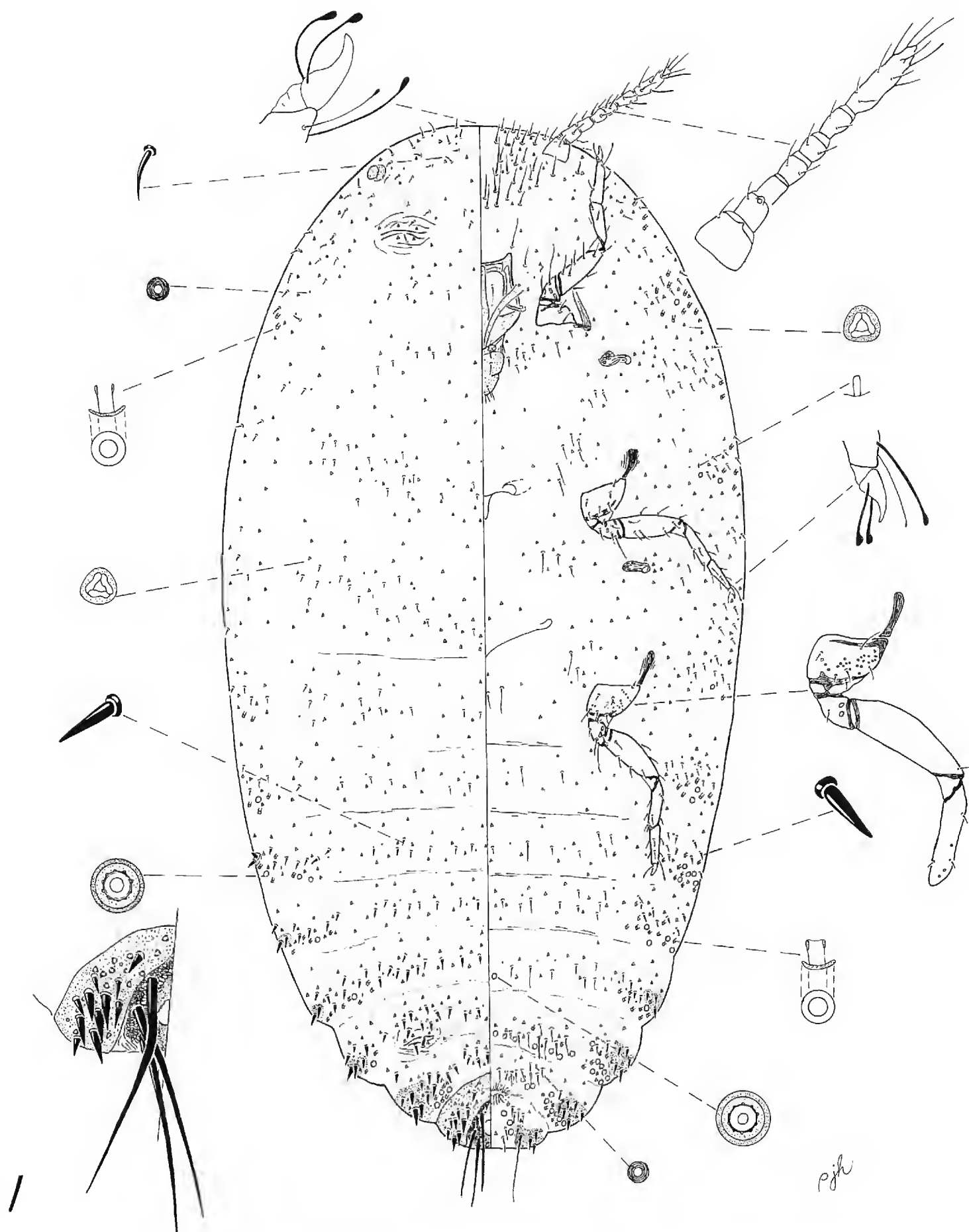


Fig. 4. Adult female holotype of *Hypogeococcus gilli* n. sp. Costa Rica (quarantined at San Pedro, California), VII-17-62, on "orchid leaf."

pores and discoidal pores. Antepenultimate cerarius with 8 and 11 conical setae with 2 larger than others (paratypes with 5-9 (7) conical setae), basal sclerotization, cluster of trilocular pores. Fourth cerarius with 3 and 5 conical setae with 2 larger than others (paratypes with 2-5 (3) conical setae), basal sclerotization, few trilocular pores. Fifth cerarius with 2 conical setae (paratypes with 2-3 (2) such setae),

basal sclerotization, 1 or 2 trilocular pores. With 2 kinds of setae; conical setae in medial and mediolateral areas of segments IV–VII, in mediolateral areas only of segments III and VIII; remainder of dorsum with bristle-shaped setae; longest seta on segment VII, excluding those surrounding cerarian cluster, 25 μ long (paratypes 25 and 27 μ), segment IV with 29 setae excluding those in cerarii (paratypes with 35 and 37). Trilocular and discoidal pores scattered over surface, discoidals less abundant. Multilocular pores in marginal and submarginal areas of segment II–VII on 1 side, II, IV–VII on other side (paratypes with these pores from metathorax, segments I, II, or III–VII). Oral-collar tubular ducts inconspicuous, with unusually short duct and darkly staining collar in marginal or submarginal areas of prothorax, segments I–VII on 1 side, II–VII on other side (paratypes without dorsal oral-collar tubular ducts on thorax). Ostioles obvious.

Anal ring on dorsal surface touching apex of abdomen, with 4 or 5 rows of pores; anal-ring setae broken at apex except 1, apex of unbroken seta rounded (paratypes with apices of anal-ring setae rounded), longest 217 μ long (paratypes 205 and 216 μ), longest seta 2.2 times longer than greatest diameter of anal ring (paratypes each 2.2 times).

Venter with 2 kinds of setae; conical setae restricted to marginal and submarginal areas of abdominal segments; bristle-shaped setae with longest seta on segment VII 45 μ long (paratypes 30 μ long); with 2 pairs of cisanal setae, longest seta 50 μ long (broken on paratypes); longest anal-lobe seta 187 μ long (paratypes 163 and 180 μ long); length of longest anal-ring seta/length of longest anal-lobe seta 1.2 (paratypes 1.2 and 1.3). Multilocular pores in medial and mediolateral areas of segments V–VIII (paratypes VI–VIII), in marginal and submarginal areas of segments II–IV, on thorax anterior of each spiracle, represented by 1, 2, or 3 pores in each cluster (paratypes with thoracic clusters each represented by 1–5 (3) pores). Trilocular and discoidal pores scattered over surface, least abundant near center of surface. Oral-collar tubular ducts of same size and shape as on dorsum generally in same areas as multiloculars. Ventral anal-lobe area broadly sclerotized.

Circulus absent. Hind legs with 22 translucent pores on dorsal surface of each coxa (paratypes 15–21 (18) pores), 23 and 25 pores on ventral surface of each coxa (paratypes 11–29 (21) pores); tibia with 3 and 6 pores on dorsal surface (paratypes 2–9 (5) pores), absent from ventral surface. Hind femora 125 and 127 μ long (paratypes 113–135 (127) μ); tibiae 87 and 93 μ long (paratypes 93–103 (97) μ); tarsi 73 and 75 μ long (paratypes 70–75 (73) μ); length of femur/tibia 1.4 (paratypes 1.2–1.7 (1.4) units); length of tibia/tarsus 1.2 (paratypes 1.2–1.4 (1.3) units). Leg setae bristle shaped except 2 setae at distal apex of inner side of tibia; tibia with 9 and 10 setae (paratypes 9–10 (9) setae); tarsal digitules extending beyond apex of claw, apical clubs of unequal size; claw digitules extending beyond apex of claw, equal in size, about equal in size to largest tarsal digitule. Antennae 7-segmented, 260 μ long (paratypes 246–273 (256) μ). Labium with basal segment separate, 75 μ long (paratypes 87 and 100 μ). Eye without associated pores.

Comparison.—*Hypogeococcus gilli* is similar to *H. barbarae* by having trilocular pores. For a comparison of these species see the description of the latter. A comparison of *H. gilli* is also made in the description of *H. boharti*.

Hypogeococcus hamoni Miller, NEW SPECIES

Etymology.—The species epithet is named in honor of Dr. Avas B. Hamon,

Florida Department of Agriculture and Consumer Services, Gainesville, for providing specimens of many interesting mealybugs from Florida including this species.

Type data.—Holotype adult ♀, single specimen on slide, with left label “Hypogeococcus/hamoni/Miller/HOLOTYPE”; right label “Palatka, Fla./17 VI 1980/on/Eriocaulon/compressum/DPI#126354/draw imm. USNM/Balsam” (USNM). In addition, there are 2 adult female paratypes on 2 slides with the same data (FSCA and BMNH).

ADULT FEMALE (4TH INSTAR)
(Fig. 5)

Description.—Holotype, mounted 1.6 mm long (paratypes 1.6 and 1.8 mm), 0.9 mm wide (paratypes 0.8 and 1.0 mm). Body elongate.

Dorsum with 4 and 5 pairs of cerarii (paratypes with 5). Anal-lobe cerarius, including ventral area with conical setae, with basal sclerotization, 0 and 1 bristle-shaped setae, 10 and 11 conical setae, no pores (paratypes with 10–11 (10) conical setae, 0–2 (1) bristle-shaped setae, no multilocular or discoidal pores). Penultimate cerarius with weak basal sclerotization, 5 conical setae, without pores (paratypes with 3–4 (4) conical setae). Antepenultimate cerarius without basal sclerotization, 2 and 3 conical setae, no associated pores (paratypes with 2 conical setae). Fourth cerarius without basal sclerotization, 2 conical setae, no pores (paratypes also with 2 conical setae). Fifth cerarius absent from 1 side, with 1 conical seta on other, without pores (paratypes with 1–2 (1) conical setae). With 2 kinds of setae; basally enlarged bristle-shaped setae restricted to medial areas of segments VI and VII; bristle-shaped setae scattered elsewhere, all about same size except larger near anterior and posterior apices of body; longest seta on segment VII, excluding those surrounding cerarian cluster, 40 μ long (paratypes 40 and 45 μ), segment IV with 18 setae, excluding those in cerarii (paratypes with 16 and 19 setae). Trilocular pores absent. Discoidal pores scattered over surface. Multilocular pores present over surface, least abundant in center of body and near posterior apex. Oral-collar tubular ducts with inconspicuous collar, short, in marginal or submarginal areas of head to segment VII, in medial and mediolateral areas of segments III–VII (paratypes with medial or mediolateral oral collars on segments IV and V on 1 specimen, on III–VII on other). Ostioles small and inconspicuous.

Anal ring dorsal, touching apex of abdomen, with 7–9 rows of pores; anal-ring setae with acute apices, longest seta 143 μ long (paratypes 143 and 140 μ), longest seta 1.4 times longer than greatest diameter of ring (paratypes 1.5 and 1.4 times).

Venter with bristle-shaped setae only, excluding setae in cerarii; longest seta on segment VII 25 μ long (paratypes 37 μ); with 2 pairs of cisanal setae, longest cisanal seta 40 μ long (paratypes 40 and 30 μ); anal-lobe setae broken on all specimens. Multilocular pores scattered over surface, most abundant near posterior margin of segments V–VII, sparse in medial areas of segments I–III. Trilocular pores absent. Discoidal pores in small numbers over surface. Oral-collar tubular ducts of same size and shape as on dorsum; in marginal or submarginal areas of prothorax to segment VIII, in medial or mediolateral areas of segments V–VII (paratypes with marginal and submarginal oral collars from head or prothorax to segment VII, medial oral collars absent from 1 specimen, on segments VI and VII on other). Ventral anal-lobe area broadly sclerotized, with several bristle-shaped setae.

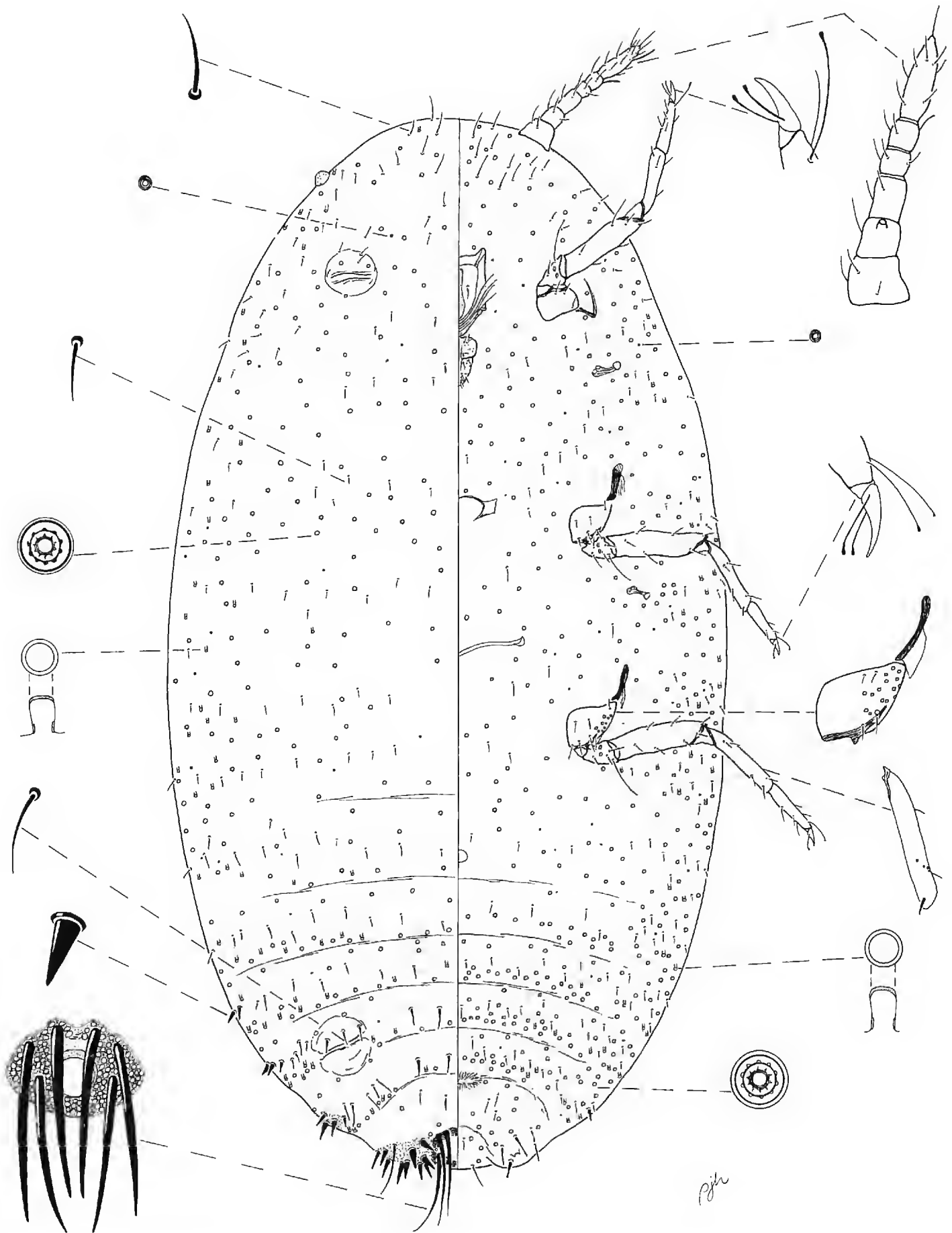


Fig. 5. Adult female holotype of *Hypogeococcus hamoni* n. sp. Palatka, Florida, VI-17-80, on *Eriocaulon compressa*.

Circulus oval, width/length 1.3 (paratypes 1.4 units) not divided, 29 μ wide (paratypes 31 and 33 μ). Hind legs with 14 and 17 translucent pores on dorsal surface of each coxa (paratypes 11–19 (15) pores), 9 and 11 pores on ventral surface of each coxa (paratypes 10–21 (17) pores); tibia without pores 1 side with 7 pores on other (paratypes 0–4 (2) pores). Hind femora 177 and 180 μ long

(paratypes 187–195 (191) μ); tibiae 150 and 160 μ long (paratypes 157–167 (164) μ); tarsi 83 and 95 μ long (paratypes 93–103 (99) μ); length of femur/tibia 1.1 and 1.2 (paratypes 1.1–1.2 (1.2) units); length of tibia/tarsus 1.7 and 1.8 (paratypes 1.6–1.8 (1.7) units). Tibia with 7 setae (paratypes with 5–7 (6) setae). Leg setae bristle shaped; tarsal digitules not quite reaching tip of claw, digitules of hind 2 pairs of legs unequal in length, with apical clubs of approximately same size, digitules of front legs unequal, 1 without apical club, other similar to digitule of hind tarsi; claw digitules extending beyond apex of claw, equal in size, about equal to largest tarsal digitule. Antennae 6-segmented (paratypes 6-segmented and 7-segmented), with third segments partially divided, 217 μ long (paratypes 210–230 (222) μ), with bristle-shaped setae. Labium with basal segment fused with second segment, 85 μ long (paratypes 85 and 87 μ). Eyes without associated pores.

Comparison.—Adult females of *Hypogeococcus hamoni* and *H. margaretae* are similar; both lack multilocular pores associated with anal-lobe cerarius, have the anal ring with 7–9 rows of pores, have translucent pores on the hind coxa and tibia, have the hind femora longer than 177 μ and the hind tibia longer than 140 μ , and have the basal labial segment closely appressed to the second segment. *Hypogeococcus hamoni* differs by having 10–11 (10) conical setae in each anal-lobe cerarius, having few or no enlarged bristle-shaped setae on the dorsum, having 16–19 (18) dorsal setae on segment IV excluding those in the cerarii, having short setae (longest seta on dorsum of segment VII 40–45 μ long, longest seta on venter of segment VII 25–37 μ long, longest cisanal seta 30–40 μ long), having 5–7 (6) setae on each hind tibia, and having 6- or 7-(6-)segmented antennae; *H. margaretae* has 24–40 (26) conical setae in each anal-lobe cerarius, has numerous, conspicuous enlarged bristle-shaped setae over the dorsum, has 33–48 (42) dorsal setae on segment IV excluding those in cerarii, has long setae (longest seta on dorsum of segment VII 57–80 (68) μ long, longest seta on venter of segment VII 35–50 (42) μ long, longest cisanal seta 60–123 (85) μ long), has 8–9 (9) setae on each hind tibia, and has 5- or 6-(5-)segmented antennae. The above mentioned species share with *H. spinosus* the occurrence of enlarged leg setae, short anal-ring setae, and the basal labial segment which is closely appressed with the second segment. *Hypogeococcus spinosus* is readily separated by having dorsomedial conical setae on abdominal segments II and III, having 2 or 3 rows of pores in the anal ring, having 4 pairs of cisanal setae, having 7-segmented antennae, and having hind length of tibia/tarsus about 1.3; *H. hamoni* and *H. margaretae* differ by having dorsomedial conical setae absent from abdominal segments II and III, having 7–9 rows of pores in the anal ring, having 3 pairs of cisanal setae, usually having less than 7-segmented antennae, and having hind length of tibia/tarsus about 1.7 or 1.8.

Hypogeococcus margaretae Miller, NEW SPECIES

Etymology.—The species epithet is formed in honor of Mrs. Margaret E. Russell Bohart, who has been a major contributor to the scientific achievements of the Bohart regime at Davis. It is clear that many of the research and administrative achievements of Dick Bohart could not have been accomplished without Margaret's devotion to science and support of many, necessary behind-the-scenes activities. Therefore, it is appropriate that Margaret Bohart be honored along with her husband.

Type data.—Holotype adult ♀, single specimen on slide, with left label “Hypogeococcus/margaretæ/Miller/HOLOTYPE”; right label “nr. Port St. Lucie, 0.3 mi N. Hiway 609/on Hiway 709, St./Lucie Co., Fla./17-XII-1981/K. Hibbard/on Eriocaulon/decanulare/DPI-126357” (USNM). In addition there are 11 paratypes on 11 slides from the same locality collected on the same date, 25 paratypes on 25 slides from the same locality collected 28-VII-1982, and 4 paratypes on 2 slides from Jackson Co., Mississippi, V-2-76, B. J. Muse, on *Eriocaulon* sp. Paratype slides have been deposited in AUA, BMNH, CDAS, FSCA, IZAS, MCM, MNHP, SIE, UCD, UG, UH, USNM, VPI, and ZIL.

ADULT FEMALE (4TH INSTAR)

(Fig. 6)

Description.—Holotype, mounted, 1.8 mm long (paratypes 1.4–2.6 (2.1) mm), 0.9 mm wide (paratype 0.8–1.3 (1.0) mm). Body elongate.

Dorsum with 4 and 6 pairs of cerarii (paratypes with 4–6 (5) cerarii). Anal-lobe cerarius including ventral area with conical setae, with basal sclerotization, 25 and 26 conical setae, no pores (paratypes with 24–30 (26) conical setae, 0–3 (0) enlarged, bristle-shaped setae, no multilocular pores, 0–1 (0) sclerotized discoidal pores). Penultimate cerarius defined by basal sclerotization extending onto ventral surface with 13 and 15 conical setae, without pores (paratypes with 12–16 (14) conical setae). Antepenultimate cerarius with basal sclerotization, 5 and 8 conical setae, no associated pores (paratypes with 4–8 (6) conical setae). Fourth cerarius with basal sclerotization, 3 and 4 conical setae, no pores (paratypes with 3–6 (4) conical setae). Fifth cerarius without basal sclerotization, with 1 and 2 conical setae, without associated pores (paratypes with or without basal sclerotization, with 1–5 (2) conical setae). Sixth cerarius absent from 1 side, on other side without basal sclerotization and associated pores, with 2 conical setae (paratypes with sixth cerarius on 6 of 10 specimens, when present, without basal sclerotization and associated pores, with 1–2 (1) conical setae). With 2 kinds of setae; conical setae on medial areas of segments VI and VII (on paratypes on any or all of segments IV–VII), on mediolateral areas of segments V–VII (on paratypes on any or all of segments III–VII), on submarginal areas of segment VII (paratypes usually with these setae on 1 or more of segments III–VII); enlarged, bristle-shaped setae scattered over remainder of surface, largest posteriorly and anteriorly, smallest in center of body; longest seta on segment VII, excluding those surrounding cerarian cluster, 63 μ long (paratypes 57–80 (68) μ), segment IV with 42 setae, excluding those in cerarii (paratypes with 33–48 (42) setae). Trilocular pores absent. Discoidal pores represented by small, irregular sclerotized spots, distributed in same relative abundance as multilocular pores. Multilocular pores scattered over surface, least abundant on posterior portion of abdomen, becoming numerous on abdominal segments I or II, numerous on thorax and head. Oral-collar tubular ducts with inconspicuous collar, unusually short for mealybug, in marginal or submarginal areas of segments V–VII (paratypes with ducts absent or on 1, and some, or all of segments IV–VII). Ostioles small and usually inconspicuous.

Anal ring dorsal, usually touching apex of abdomen, with 7–9 rows of pores; anal-ring setae with acute apices, longest seta 133 μ long (paratypes 125–150 (139) μ), longest seta 1.4 times longer than greatest diameter of ring (paratypes 1.3–1.7 (1.5) times).

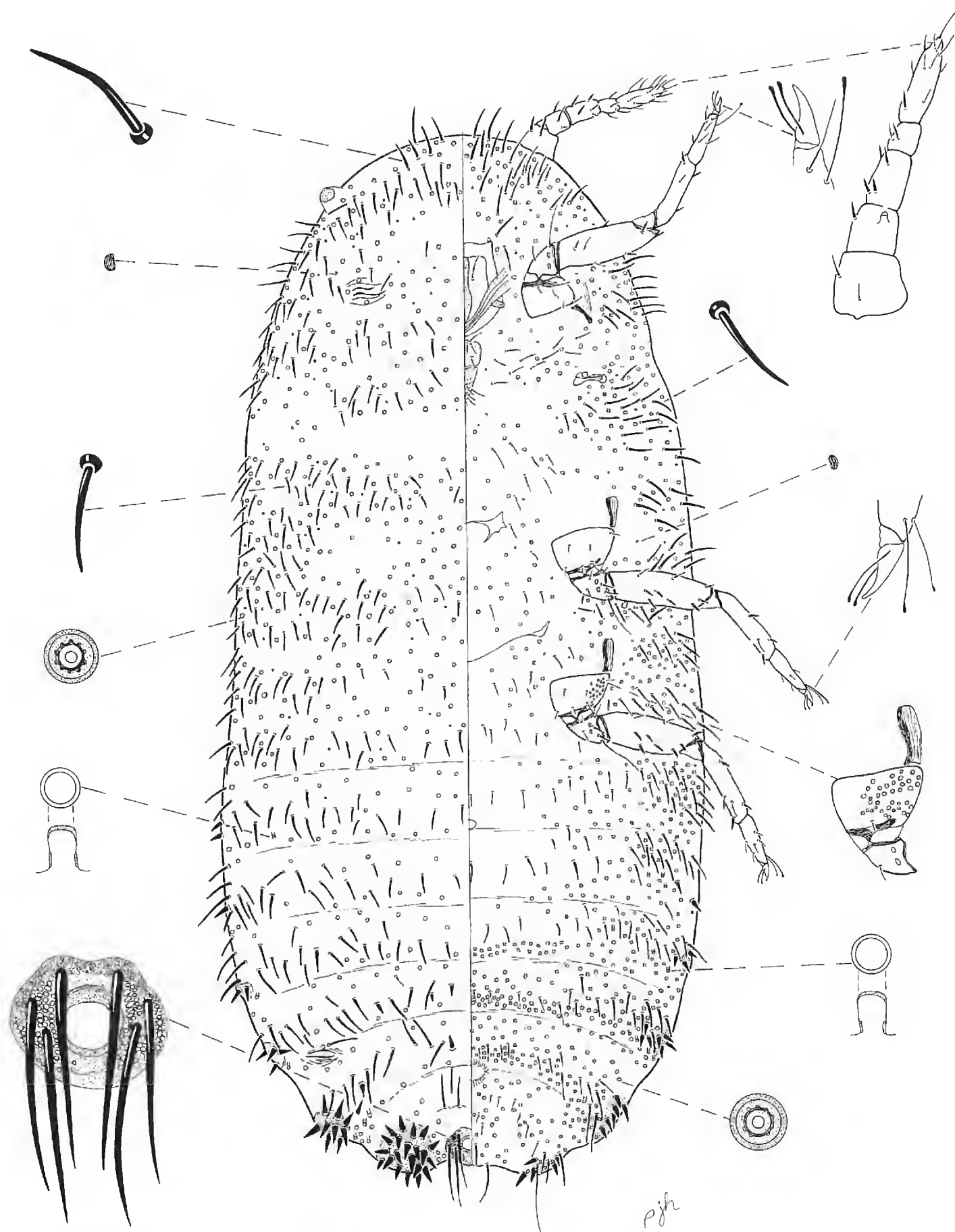


Fig. 6. Adult female holotype of *Hypogeococcus margaretae* n. sp. near Port St. Lucie Co., Florida, XII-17-81, on *Eriocaulon decangulare*.

Venter with 3 kinds of setae; conical setae restricted to marginal and submarginal areas of abdomen; enlarged, bristle-shaped setae in marginal and submarginal clusters except on anterior apex of head, medial setae on segments III-V slightly enlarged; bristle-shaped setae in medial and mediolateral areas of abdomen, thorax, and head, excluding segments III-V, also on anterior apex of head; longest bristle-

shaped seta on segment VII 45 μ long (paratypes 35–50 (42) μ); with 2 pairs of cisanal setae, longest seta 77 μ long (paratypes 60–123 (85) μ); longest anal-lobe seta 170 μ long (paratypes 163–205 (182) μ); length of longest anal-ring seta/length of longest anal-lobe seta 0.8 (paratypes 0.7–0.9 (0.8) units). Multilocular pores abundant over surface, absent or sparse in medial areas of segments II–IV or V. Trilocular pores absent. Discoidal pores of same nature and distribution as on dorsum. Oral-collar tubular ducts of same size and shape as on dorsum, on marginal or submarginal areas of segments II or III–VII (paratypes often with fewer ducts on fewer segments). Ventral anal-lobe area broadly sclerotized, somewhat indefinite anteriorly, apparently with conical setae, bristle-shaped setae, and multilocular pores.

Circulus oval, width/length 1.5 (paratypes 1.3–1.7 (1.5) units) not divided, 25 μ wide (paratype 20–30 (25) μ). Hind legs with 30 and 35 translucent pores on dorsal surface of each coxa (paratypes 30–46 (38) pores), 18 and 26 pores on ventral surface of each coxa (paratypes 20–44 (27) pores); tibia without pores (paratypes without pores on 5 of 10 specimens, when present, located on dorsal surface at distal apex, with 1–6 (3) pores). Hind femora 210 and 213 μ long (paratypes 195–217 (205) μ); tibiae 167–170 μ long (paratypes 147–170 (159) μ); tarsi 93 and 90 μ long (paratypes 80–90 (87) μ); length of femur/tibia 1.3 (paratypes 1.2–1.4 (1.3) units); length of tibia/tarsus 1.8 (paratypes 1.7–1.9 (1.8) units). Tibia with 9 setae (paratypes 8–9 (9) setae). Leg setae bristle shaped except for some setae on trochanter, femur, and tibia as follows: hind trochanter with enlarged bristle-shaped seta on lower-distal portion (as drawn) (paratypes sometimes with 2 enlarged at distal end); hind femur with enlarged, bristle-shaped setae on ventral surface at distal end of segment and posterior edge (as drawn) (paratypes often with setae on anterior edge also enlarged); hind tibia with enlarged, bristle-shaped setae on ventral surface at distal end of segment and along anterior margin (as drawn) (paratypes occasionally with enlarged seta on posterior margin near middle of segment); front legs with few enlarged, bristle-shaped setae on femur (paratypes often with many more enlarged setae on front femur); tarsal digitules usually not quite reaching tip of claw, digitules of hind 2 pair of legs unequal in length, with apical clubs of approximately same size (1 or 2 paratypes with digitules apparently of same length), digitules of front legs unclear (paratypes with front digitules unequal, 1 without apical club, other similar to digitule of hind tarsi); claw digitules extending beyond apex of claw, equal in size, about equal to largest tarsal digitule. Antennae 5-segmented (3 of 10 paratypes with third segment partially divided), 255 and 260 μ long (paratypes 225–260 (245) μ); with enlarged, bristle-shaped setae on anterior margin (as drawn) of segments 1–5 (paratypes on segments 1–3, 4, or 5). Labium with basal segment closely attached to second segment, 87 μ long (80–100 (89) μ). Eye without associated pores.

Comparison.—A comparison is given of the adult females of *Hypogeococcus margaretae* and *H. hamoni* in the treatment of the latter species.

THIRD-INSTAR FEMALE

(Fig. 7)

Specimens examined.—The following description is based on 3 specimens collected near Port St. Lucie, Florida on 28-VII-1982.

Description.—Mounted, 1.1–1.2 (1.2) mm long, 0.5–0.6 (0.5) mm wide. Body elongate.

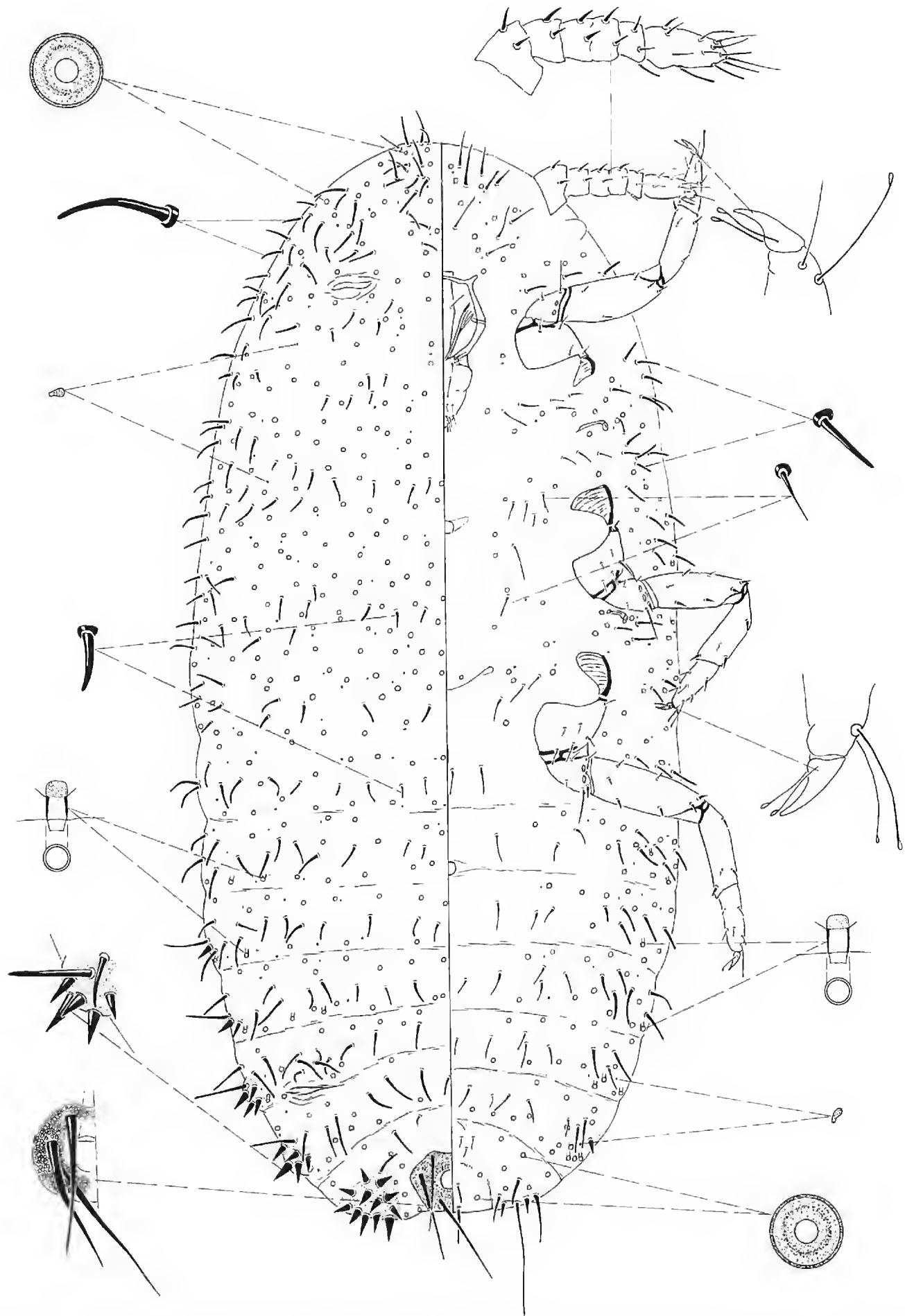


Fig. 7. Third-instar female paratype of *Hypogeococcus margaretae* n. sp. near Port St. Lucie, Florida, VII-28-82, on *Eriocaulon decangulare*.

Dorsum with 4 or 5 (5) pairs of cerarii. Anal-lobe cerarius with basal sclerotization, 12-14 (13) conical setae, 1-3 (2) enlarged, bristle-shaped setae, 1 specimen with 3 discoidal pores, remaining specimens without pores. Penultimate cerarius with basal sclerotization, 6 or 7 conical setae, 1-3 (2) enlarged, bristle-shaped setae, no pores. Antepenultimate cerarius with basal sclerotization, 4-5

(4) conical setae, 0–1 (1) enlarged, bristle-shaped setae, no pores. Fourth cerarius with basal sclerotization, 1–5 (3) conical setae, 0–2 (1) enlarged, bristle-shaped setae, no pores. Fifth cerarius, when present, with 1–3 (2) conical setae, 1–2 (1) enlarged, bristle-shaped setae, no pores. With 1 or 2 kinds of setae; 1 conical seta present on 1 specimen, located dorsomedially on segment VII, absent from remaining specimens; enlarged, bristle-shaped setae scattered over surface; longest seta on segment VII, excluding those surrounding cerarian cluster, 40–49 (45) μ long, segment IV with 19–22 (20) setae, excluding those in cerarii. Trilocular pores absent. Discoidal pores represented by small, irregular sclerotized spots, distributed in same relative abundance as multilocular pores. Multilocular pores present over surface, most abundant on thorax. Oral-collar tubular ducts in marginal or submarginal areas on any or all of segments II–VII. Ostioles small.

Anal ring dorsal, touching apex of abdomen, with 5 or 6 (6) rows of pores; anal-ring setae with acute apices, longest seta 111–119 (115) μ long, longest seta 1.5–1.7 (1.6) times longer than greatest diameter of ring.

Venter with 2 kinds of setae; abdominal segments each with 10 or more setae; enlarged, bristle-shaped setae in marginal and submarginal areas except on head, with 3–5 setae cluster near each lateral margin of each segment; bristle-shaped setae scattered over remainder of surface; longest bristle-shaped seta on segment VII 32–47 (41) μ long; with 2 pairs of cisanal setae, longest seta 52–62 (58) μ long; longest anal-lobe seta 143–148 (145) μ long; length of longest anal-ring seta/length of longest anal-lobe seta 0.8. Multilocular pores most abundant on thorax, usually absent from medial areas of segments I or II to VI or VII. Trilocular pores absent. Discoidal pores of same nature and distribution as on dorsum. Oral-collar tubular ducts on marginal and submarginal areas of metathorax and all or some of segments III to VII. Ventral anal-lobe area broadly sclerotized, with several enlarged, bristle-shaped setae, sometimes with 1 or 2 conical setae, 1 bristle-shaped seta, several multilocular pores.

Circulus oval, width/length 1.1–1.3 (1.2), 17–20 (18) μ wide. Hind legs with trace of translucent pores on coxa; hind femora 138–146 (142) μ long; tibiae 101–109 (105) μ long; tarsi 77–79 (78) μ long; length of femur/tibia 1.3–1.4 (1.3); length of tibia/tarsus 1.3–1.4 (1.4). Tibia with 7 setae. Leg setae bristle shaped except for some enlarged, bristle-shaped setae on trochanter, femur, and tibia; tarsal digitules of hind 2 pairs of legs unequal in length, with apical clubs of approximately same size, digitules of front legs unequal, 1 without club, other similar to digitules of hind tarsi; claw digitules extending beyond apex of claw, equal in size. Antennae 5-segmented, third segment sometimes partially divided, 180–203 (192) μ long; enlarged, bristle-shaped setae on anterior margin (as drawn) of segments 1–3 or 4. Labium with basal segment closely attached to second segment, 77–79 (78) μ long. Eyes without associated pore.

Comparison.—Third instar of *Hypogeococcus margaretae* and *H. boharti* differ by the former having 12–14 (13) conical setae in each anal-lobe cerarius, enlarged, bristle-shaped setae scattered over dorsum, oral-collar tubular ducts absent from head and medial areas, anal ring with 5 or 6 rows of pores, longest anal-ring seta 111–119 (115) μ long, longest cisanal seta 52–62 (58) μ long, longest anal-lobe seta 143–148 (145) μ long, hind femur 138–146 (142) μ long, tibia/tarsus ratio 1.3–1.4 (1.4), tibiae each with 7 setae, some leg setae enlarged, antennae 5-segmented, eye without associated pores; *H. boharti* has 4–5 (4) conical setae in each

anal-lobe cerarius, no enlarged, bristle-shaped setae, oral-collar tubular ducts on head and dorsomedial areas of abdomen, anal ring with 2 rows of pores, longest anal-ring seta 145–170 μ , longest cisanal seta 27 μ long, longest anal-lobe seta 103–115 μ long, hind femur 105–117 (110) μ long, length of tibia/tarsus ratio 1.1, tibiae each with 9 setae, no enlarged leg setae, antennae 6-segmented, eye with associated pores.

Third-instar females of *H. margaretae* can be separated from second-instar females of the same species by having more dorsal setae (segment IV with about 20 setae), more cerarian setae (anal-lobe cerarius with about 13 conical setae), longer anal-lobe setae (about 145 μ long), and length of tibia/tarsus about 1.4; second-instar females have 7 setae on segment IV, 4 or 5 conical setae in each anal-lobe cerarius, anal-lobe setae about 128 μ long, and length of tibia/tarsus about 1.1.

SECOND-INSTAR FEMALE

(Fig. 8)

Specimens examined.—The following description is based on 2 specimens collected near Port St. Lucie, Florida on 28-VII-1982.

Description.—Mounted, 0.9 mm long, 0.4 mm wide. Body elongate.

Dorsum with 5 pairs of cerarii. Anal-lobe cerarius with basal sclerotization, 4 or 5 conical setae, 0 or 1 enlarged, bristle-shaped seta, no pores. Penultimate cerarius with basal sclerotization, 3 conical setae, 0 or 1 enlarged, bristle-shaped seta, no pores. Antepenultimate cerarius with basal sclerotization, 1 or 2 conical setae, 0 or 1 enlarged, bristle-shaped seta, no pores. Fourth and fifth cerarii each with basal sclerotization, 1 conical seta, 1 enlarged, bristle-shaped seta, no pores. With 1 kind of seta; enlarged, bristle-shaped setae scattered over surface, largest posteriorly and anteriorly, smallest in center of body; longest seta on segment VII 37 μ long, segment IV with 7 setae, excluding those in cerarii. Trilocular pores absent. Discoidal pores represented by small, irregular sclerotized spots, present near multilocular pores. Multilocular pores scattered over surface, most abundant anteriorly. Oral-collar tubular ducts in marginal areas on any or all of segments II–VII. Ostioles small.

Anal ring dorsal, touching apex of abdomen, with 4 or 5 rows of pores; anal-ring setae with acute apices, longest seta 89 and 99 μ long, longest seta 1.5 and 1.6 times longer than greatest diameter of ring.

Venter with 2 kinds of setae, abdominal segments each with 6–10 (8) setae; enlarged, bristle-shaped setae in marginal areas on segments III or IV to VII, with 1 seta near each lateral margin of each segment; bristle-shaped setae scattered over remainder of surface; longest bristle-shaped seta on segment VII 25 μ long; with 2 pairs of cisanal setae, longest seta 25 and 32 μ long; longest anal-lobe seta 126 and 131 μ long; length of longest anal-ring seta/length of longest anal-lobe seta 0.7 and 0.8. Multilocular pores most abundant on thorax, absent from medial areas of segments IV or V to VIII. Trilocular pores absent. Discoidal pores of same nature and distribution as on dorsum. Oral-collar tubular ducts on marginal or submarginal areas of metathorax and all or any of segments V–VII. Ventral anal-lobe area sclerotized, with enlarged, bristle-shaped setae.

Circulus oval, width/length 1.2 and 1.3, 12 μ wide. Hind legs without translucent pores. Hind femora 103 μ long; tibiae 74 μ long; tarsi 67 and 69 μ long; length

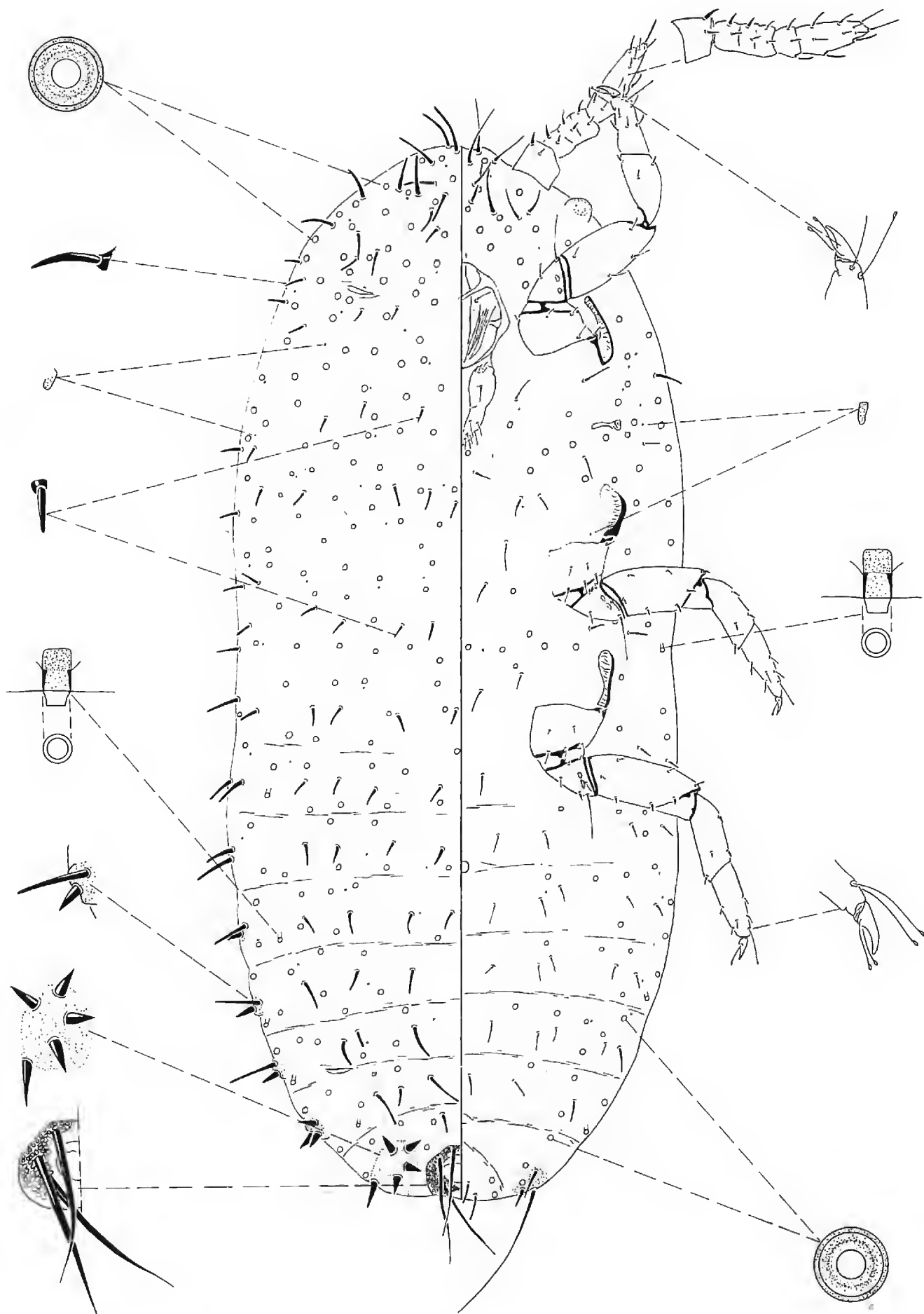


Fig. 8. Second-instar female paratype of *Hypogeococcus margaretae* n. sp. near Port St. Lucie, Florida, VII-28-82, on *Eriocaulon decangulare*.

of femur/tibia 1.4; length of tibia/tarsus 1.1. Tibia with 7 setae. Leg seta bristle shaped except for some enlarged, bristle-shaped setae on femur, tibia, and sometimes trochanter and tarsus; tarsal digitules reaching tip of claw, digitules of hind 2 pairs of legs subequal in length, with apical clubs of approximately same size,

digitules of front legs unequal, 1 without club, other similar to digitule of hind tarsi; claw digitules extending beyond apex of claw, equal in size. Antennae 5-segmented, third segment partially divided, 160 and 168 μ long; enlarged, bristle-shaped setae on anterior margin (as drawn) of segments 1-3 or 4. Labium with basal segment closely attached to second segment, 67 μ long. Eyes without associated pores.

Comparison.—Second instars of *H. margaretae* can be separated from first instars of the same species by having 4 or 5 conical setae in each anal-lobe cerarius, 4 dorsal setae on segment IV, no trilocular pores, many multilocular pores, and marginal oral-collar tubular ducts; first instars have 2 conical setae in each anal-lobe cerarius, 7 dorsal setae on segment IV, many trilocular pores, and no multilocular pores or oral-collar tubular ducts.

For a comparison of second-instar males and females of *H. margaretae* see the comparison section of the second-instar male. For a comparison of third-instar and second-instar females, see the comparison section of the third-instar female.

SECOND-INSTAR MALE

Specimen examined.—The following description is based on 1 specimen collected near Port St. Lucie, Florida on 28-VII-1982.

Description.—Second-instar males are very similar to second-instar females. Only differences are given here.

Dorsum with 4 or 5 pairs of cerarii. Anal-lobe cerarius with 2 conical setae, 3 enlarged, bristle-shaped setae. Penultimate cerarius with 2 conical setae, no bristle-shaped setae. Remaining 2 or 3 cerarii each with 1 conical seta and 1 enlarged, bristle-shaped seta. Longest seta on segment VII 35 μ long. Oral-collar tubular ducts in marginal and mediolateral areas of most of surface.

Anal-ring with longest seta 79 μ long, longest seta 1.5 times longer than greatest diameter of ring.

Venter with longest bristle-shaped seta on segment VII 25 μ long; longest cisanal seta 30 μ long; longest anal-lobe seta 148 μ long; length of longest anal-ring seta/length of longest anal-lobe seta 0.5. Oral-collar tubular ducts on marginal areas from head to thorax.

Circulus width/length 1.2, 12 μ wide. Hind femora 99 μ long; tibia 72 μ long; tarsus 62 μ long; length of tibia/tarsus 1.2. Antennae 6-segmented, 151 μ long. Labium 64 μ long.

Comparison.—Male and female second instars can be distinguished by the former having fewer conical setae in the hind 2 pairs of cerarii, more oral-collar tubular ducts scattered over most of the dorsum, and by having 6-segmented antennae.

FIRST INSTAR (Fig. 9)

Specimen examined.—The following description is based on 1 first instar paratype from near Port St. Lucie, Florida collected 28-VII-1982 and 8 embryos that are inside 3 of the 4 adult female paratypes collected in Jackson Co., Mississippi.

Description.—Only salient features are included because of the poor condition of the available material.

Mounted, 380-632 (445) μ long, 187-304 (219) μ wide. Body elongate oval.

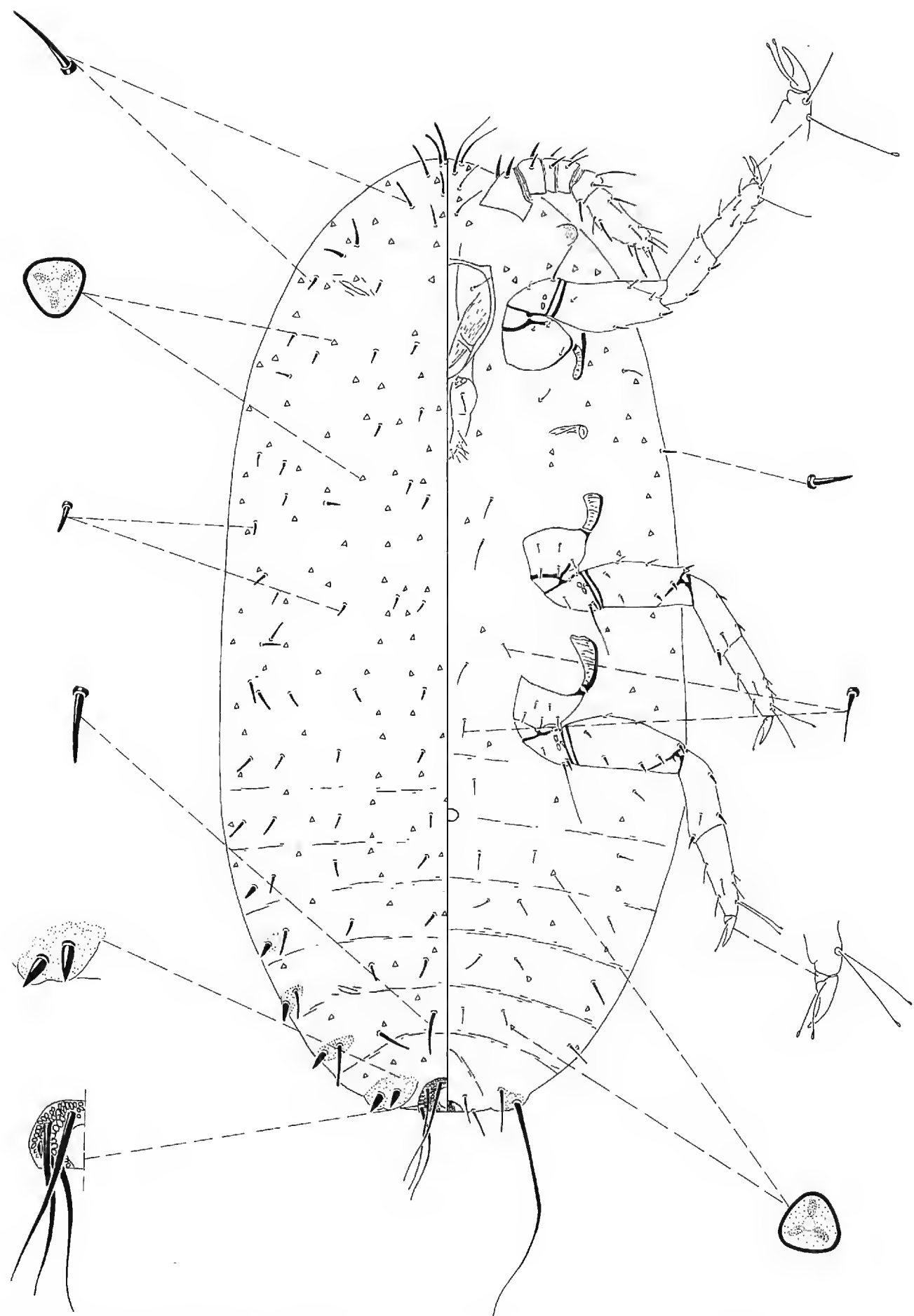


Fig. 9. First-instar paratype of *Hypogeococcus margaretae* n. sp. near Port St. Lucie, Florida, VII-28-82, on *Eriocaulon decangulare*.

Dorsum with 4–7 (5) pairs of cerarii that have at least 1 conical seta, with about 12 paired, enlarged bristle-shaped setae along each body margin in form of cerarii including those with conical setae; cerarii without associated pores, with basal sclerotization. Anal-lobe cerarii with 2 conical setae; penultimate cerarii with 1–2 (2) conical setae and 0–1 (0) enlarged, bristle-shaped setae; antepenultimate and

fourth cerarii each with 1-2 (1) conical setae and 0-1 (0) enlarged, bristle-shaped setae; fifth cerarii with 0-1 (1) conical setae and 1-2 (1) enlarged, bristle-shaped setae; sixth and seventh cerarii each with 0-1 (0) conical setae and 1-2 (2) enlarged, bristle-shaped setae; remaining cerarii each with 2 enlarged, bristle-shaped setae. With 2 kinds of setae; conical setae restricted to cerarii except 1 specimen has 1 such seta in medial area of segment 5; enlarged, bristle-shaped setae scattered over dorsum, arranged in 4 longitudinal lines on most of abdomen, excluding setae in cerarii, with extra setae on thoracic segments, shortest setae in center of body; longest seta on segment VII, excluding those in cerarii, 23-32 (27) μ long, segment IV with 4 setae including those in cerarii. Trilocular pores scattered over surface most abundant on thorax, on abdomen usually with 6 longitudinal lines of pores with transverse row of pores located near anterior and posterior margin of each anterior abdominal segment, forming 6 or 8 longitudinal lines of trilocular pores on abdomen. Discoidal and multilocular pores absent. Tubular ducts absent. Ostioles present.

Anal ring apical, with 3 or 4 rows of pores; anal-ring setae with acute apices, longest seta 63-77 (71) μ long.

Venter with 2 kinds of setae, forming 6 longitudinal lines of setae on abdomen; enlarged, bristle-shaped setae restricted to submarginal areas of posterior 2 or 3 abdominal segments; bristle-shaped setae on rest of surface; longest bristle-shaped setae on segment VII about 20 μ long; with 2 pairs of cisanal setae; longest anal-lobe seta 87-151 (124) μ long. Trilocular pores associated with submarginal and mediolateral lines of setae on abdomen, scattered on thorax and head. Multilocular and discoidal pores absent. Tubular ducts absent. Ventral anal-lobe area sclerotized.

Circulus oval, not divided, 7-11 (9) μ wide. Legs generally unclear on embryos, on single available crawler hind femora each 79 μ long; tibiae each 59 μ long; tarsi 62 and 59 μ long; length of femur/tibia 1.3; length of tibia/tarsus 1.0. Tibia with 7 setae; leg setae bristle shaped except for some enlarged setae on trochanter, femur and tibia; tarsal digitules of hind 2 pairs of legs about equal in size, extending beyond apex of claw, of front pair of legs, each tarsus apparently with 1 long, capitate digitule and 1 short, apically acute digitule; claw digitules equal, extending beyond tip of claw. Antennae unclear on embryos, on single crawler 6-segmented, each 133 μ long; with enlarged, bristle-shaped setae on anterior margin (as drawn) of segments 1-3 or 4. Labium with basal segment closely attached to second segment, about 50 μ long. Eye without associated pores.

Comparison.—First instars of *Hypogeococcus margaretae* and *H. boharti* differ as follows: *H. margaretae* lacks a trilocular pore between the conical setae of the anal-lobe cerarius, has enlarged, bristle-shaped setae, has 2 transverse rows of trilocular pores on anterior abdominal segments, lacks ventral discoidal pores, has enlarged, bristle-shaped setae on the femora and tibiae, and lacks a discoidal pore associated with the eye; *H. boharti* has a trilocular pore between the conical setae of the anal-lobe cerarius, lacks enlarged, bristle-shaped setae, has only 1 transverse row of trilocular pores on abdominal segments, has a line of discoidal pores on the venter near the base of the submarginal setae, lacks enlarged setae on the legs, and has a discoidal pore associated with each eye. For a comparison of second instars of *H. margaretae* with first instars of the same species see the comparison section of the second-instar female.

DISCUSSION

During the course of this study special emphasis was devoted to several characters that previously were given little or no detailed study. These characters included numbers of leg setae (i.e., number of setae on hind tibia), numbers of setae on the abdomen (i.e., number of setae on the dorsum of segment IV), lengths of the abdominal setae (i.e., lengths of dorsal and ventral setae on segment VII and of the cisanal setae), numbers of cisanal setae, and relative sizes of the claw and tarsal digitules. Each of these characters has proven to be of value in distinguishing among species of *Hypogeococcus* and may be useful in other groups of mealybugs. Characteristics of the digitules were especially interesting. Features of digitules have been used in the genus *Rhizoecus* (Hambleton, 1976) and seem to characterize genera of the tribe Phenacoccini (Miller, 1975). In all of the species of *Hypogeococcus*, and in *Ferrisia virgata* (Cockerell), *Nipaecoccus nipae* (Maskell), *Paradoxococcus mcdanieli* McKenzie, *Planococcus citri* (Risso), *Pseudococcus maritimus* (Ehrhorn), *Trionymus winnemucae* McKenzie, and probably most mealybugs, the front legs have asymmetrical tarsal digitules, with one digitule on each leg capitate and with the other digitule bristle shaped and without an enlarged apex. Both tarsal digitules of each of the mesothoracic and metathoracic legs usually are capitate, although one usually is much more robust than the other. The claw digitules usually are larger than the tarsal digitules and frequently are equal in size on all three pairs of legs. The study of embryos has proven to be of considerable value in learning about the morphology of the first instars of 2 *Hypogeococcus* species and may prove to be of use in other pseudococcid studies. Embryos have been used in armored scales (Miller *et al.*, in press) and have the added advantage of giving a clear association with an adult female.

Studies of immature forms continue to provide interesting and valuable information relative to the formulation of a usable mealybug classification. The occurrence of trilocular pores on the first instars of *Hypogeococcus* is somewhat surprising in light of the fact that *Heterococcus*, another genus of mealybug that lacks trilocular pores as adults, has only quinquelocular pores in first instars (Miller, 1975). Study of second instars of *Hypogeococcus* support the hypothesis that in most mealybugs, the second-instar male has more oral-collar tubular ducts than does the second-instar female.

It is clear that after current research on South American species is complete and adult males and first instars have been studied, the composition of *Hypogeococcus* will need to be reevaluated. It is likely that *Hypogeococcus* eventually will be divided into two or three genera.

ACKNOWLEDGMENTS

Special appreciation is extended to Dr. Manya B. Stoetzel and Dr. E. Eric Grissell, Systematic Entomology Lab., Agric. Res. Serv., U.S. Dept. Agric. and to Dr. Douglas J. Williams, Commonwealth Institute of Entomology, % British Museum (Nat. Hist.), London, England, for their valuable comments and criticisms of the manuscript. To Mr. Kenneth L. Hibbard, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Port Pierce, I give special thanks for his considerable efforts to collect and recollect material of *Hypogeococcus margaretae*. I am grateful to Ms. Helen Proctor, Systematic Entomology Lab., for typing the various drafts of the paper and to Ms. Pamela Hollyoak

for preparing most of the illustrations. I also acknowledge the assistance of Dr. Jennifer Cox and Dr. Douglas J. Williams (BMNH), Mr. Raymond J. Gill and Mr. Robert O. Schuster (UCD), and Dr. Avas B. Hamon (FSCA) for loaning specimens for this study.

LITERATURE CITED

- Beardsley, J. W. 1965. Notes on the pineapple mealybug complex, with descriptions of two new species. *Proc. Hawaii. Ent. Soc.* 19:55-68.
- Bohart, R. M. 1942. Life history of *Diaspis boisduvalii* and its control on *Cattleya* with calcium cyanide. *J. Econ. Ent.* 35:365-368.
- Brain, C. K. 1915. The Coccidae of South Africa.—I. *Trans. Roy. Soc. S. Afr.* 5:65-194.
- Cruttwell, R. E., and P. Fidalgo. 1974. Studies of the biology and host-specificity of the cactus mealybug *Hypogoecoccus festerianus* (Lizer y Trelles), attacking *Eriocereus martinii* in Argentina. Report Commonw. Inst. Biol. Control, S. Amer. Substa., 11 pp.
- De Lotto, G. 1974. On two genera of mealybugs. *J. Ent. Soc. S. Afr.* 37:109-115.
- Ezzat, Y. M., and H. S. McConnell. 1956. A classification of the mealybug tribe Planococcini. Univ. Md., Agr. Exp. Sta. Bull. A-84, 108 pp.
- Ferris, G. F. 1950. Atlas of the scale insects of North America. Vol. V. The Pseudococcidae (Part I). Stanford Univ. Press, Calif., pp. 1-278.
- . 1953. Atlas of the scale insects of North America. Vol. VI. The Pseudococcidae (Part II). Stanford Univ. Press, Calif., pp. 279-506.
- Hambleton, E. J. 1976. A revision of the New World mealybugs of the genus *Rhizoecus*. U.S. Dept. Agr. Tech. Bull. no. 1522, 88 pp.
- Lizer y Trelles, C. A. 1942. *Pedronia festeriana* n. sp. *Revista Fac. Agron. Vet. Univ. B. Aires* 10: 24-28.
- MacGillivray, A. D. 1921. The Coccidae. Scarab Co., Urbana, Ill., 502 pp.
- McFadyen, R. E. 1979. The cactus mealybug *Hypogeococcus festerianus* an agent for the biological control of *Eriocereus martinii* in Australia. *Entomophaga* 24:281-287.
- McFadyen, R. E. and Tomley, A. J. 1978. Preliminary indications of success in the biological control of *Harrisia cactus* (*Eriocereus martinii* Lab.) in Queensland. *Proc. 1st Conf. Council Aust. Weed Sci. Soc.*, pp. 108-112.
- McKenzie, H. L. 1960. A new subterranean *Rhizoecus* mealybug from Arizona. *Pan-Pac. Ent.* 36: 139-141.
- . 1967. Mealybugs of California with taxonomy, biology, and control of North American species. Univ. Calif. Press, Berkeley, 525 pp.
- Miller, D. R. 1975. A revision of the genus *Heterococcus* Ferris with a diagnosis of *Brevennia* Goux. U.S. Dept. Agr. Tech. Bull. No. 1497, 61 pp.
- Miller, D. R., J. A. Davidson, and M. B. Stoetzel. A taxonomic study of the armored scale *Pseudoschnaspis* Hempel. *Proc. Ent. Soc. Wash.* (in press).
- Miller, D. R., and H. L. McKenzie. 1971. Sixth taxonomic study of North American mealybugs, with additional species from South America. *Hilgardia* 40:565-602.
- Rau, G. J. 1938. Four more species of mealybugs from New York State. *Canad. Ent.* 70:157-165.
- Theron, J. G. 1958. Comparative studies on the morphology of male scale insects. *Ann. Univ. Stellenbosch* 34:1-71.
- Williams, D. J. 1973. Two cactus-feeding mealybugs from Argentina. *Bull. Ent. Res.* 62:565-570.
- Willink, C. G. de. 1981. Nueva especie de *Hypogeococcus* Rau de Tucuman, Republic Argentina. *Neotropica* 27:61-65.

Habitat Differences Among Container-Breeding Mosquitoes in Western Puerto Rico (Diptera: Culicidae)

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Aedes aegypti (Linn.), the vector of dengue virus in the Caribbean, has assumed major importance in recent years because of continued dengue epidemics (Neff *et al.*, 1967; Likosky *et al.*, 1973; Von Allmen *et al.*, 1979).

From 1964 to 1968, an intensive *Ae. aegypti* Eradication Program was carried out in the southeastern United States, Puerto Rico, and U.S. Virgin Islands. During that program, there was widespread removal of container habitats in the domestic and peridomestic environment and insecticidal treatment of remaining habitats. McClelland (1967) suggested that this type of treatment might profoundly affect the behavior of a "weedy" species, such as *Ae. aegypti*, by applying strong selective pressure to change breeding site selection. Intensive control would eliminate panmictic breeding, leading to higher inbreeding rates, which would further enhance rapid evolutionary change. According to McClelland (1967), any repellent quality of the insecticides used to treat larval habitats would also increase selection by inducing ovipositing females to seek untreated containers, presumably those not considered the usual types or those at some distance from houses. Moore (1977) subsequently found that Abate^{®2} and malathion, two widely used larvicides, repelled ovipositing *Ae. aegypti*.

Kellett and Omardeen (1957) found *Ae. aegypti* in Trinidad breeding in tree holes as high as 10 meters above ground level. They suggested this behavior might be related to repellent action of benzene hexachloride (BHC) used for larval control. Fox *et al.* (1960) found *Ae. aegypti* breeding in coralline rock holes in western Puerto Rico. Larvae from rock holes were found to be highly resistant to DDT, dieldrin, and lindane. Weinbren and O'Gower (1966) and Weinbren and Weinbren (1970) reported *Ae. aegypti* breeding in the Luquillo rain forest in eastern Puerto Rico. However, Haber and Moore (1973) concluded that the rain forest infestation resulted from introduction of eggs during a long-term radiation ecology experiment, and no evidence of permanent establishment was found.

The foregoing reports of habitat and behavior changes prompted a survey of *Ae. aegypti* distribution with respect to container habitat and distance from houses in western Puerto Rico. The study also provided an opportunity to evaluate possible competition between *Ae. aegypti* and the local *Ae. (Gymnometopa) mediovittatus* (Coq.) and to assess the degree of association between the various container-breeding mosquito species.

¹ Work performed while the author was on the faculty of the Department of Biology, University of Puerto Rico, Mayaguez, P.R.

² Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or by the U.S. Department of Health and Human Services.

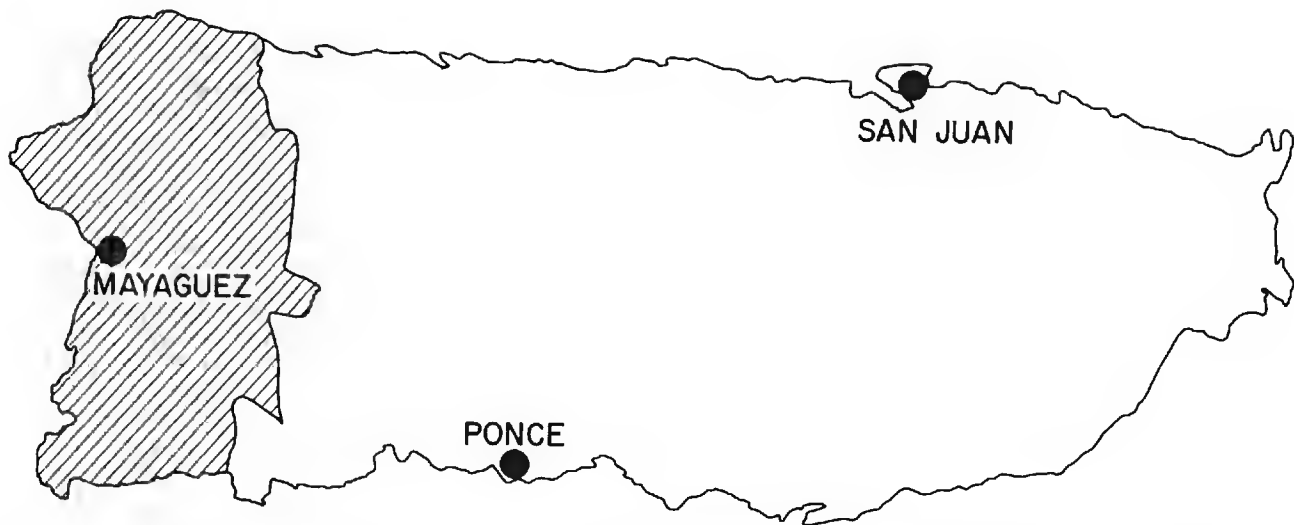


Fig. 1. Location of study area in Puerto Rico. Municipalities surveyed were Aguada, Aguadilla, Añasco, Cabo Rojo, Hormigueros, Isabela, Lajas, Las Marias, Maricao, Mayaguez, Moca, Rincon, Sabana Grande, San German, and San Sebastian.

MATERIALS AND METHODS

This study was carried out concurrently with collections of local mosquito species for the "Mosquitoes of Middle America" (MMA) project (Belkin *et al.*, 1965a, b). Egg, larval, pupal, and adult mosquito collections were made from artificial (man-made) and natural (e.g., tree holes, rock holes, plant axils) water-holding containers or holes around rural dwellings in 15 municipalities in western Puerto Rico (Fig. 1), from January through June, 1971. Collecting methods were as described by Belkin *et al.* (1965b), and collection data were recorded on the standardized MMA collection form. Distance from the nearest house was also estimated and noted on the collection form. Collections were returned to the laboratory for identification. Scrapings and other collections of dried material were flooded with water and subjected to vacuum for 15 to 30 minutes to induce hatching. Samples that did not produce larvae were dried and then flooded a second time. Samples producing no larvae after the second flooding were considered to be negative.

Larvae were reared in enamel pans ($18 \times 30 \times 5$ cm) containing approximately 1 liter of 0.01 M NaCl solution in place of tap water and were fed finely ground rabbit food. Larvae were identified in the fourth instar and, when appropriate, samples were preserved for the MMA project. When less common species were collected, individual rearings were carried out to preserve larval and pupal skins with the associated adults (Belkin *et al.*, 1965b). Representative samples of the material collected were deposited in the MMA project collection (Belkin and Heinemann, 1975), which is now located at the Smithsonian Institution.

Habitats were grouped by type and distance from the nearest human habitation. Container habitats were grouped according to source (artificial or natural) and size. Later, several groups were pooled to obtain reasonable sample sizes. The final categories were: 1) artificial containers—a) containers of 20-liter capacity or greater and b) containers of less than 20-liter capacity, and 2) natural containers of all sizes. The number of containers decreased as distance from houses increased. Most houses were grouped together and not separated from other houses by great distances; also, inspectors were less likely to discover all containers farther away

Table 1. Availability of distance data, type of sample and positivity of samples for 772 artificial and natural container habitats in western Puerto Rico, January–June 1971.

	Type of sample		Total
	Larvae/pupae	Scrapings	
Positive samples			
Distance known	383	8	391
Distance unknown	209	12	221
Total	592	20	612
Negative samples			
Distance known	2	79	81
Distance unknown	3	76	79
Total	5	155	160
Total samples	597	175	772

from houses. Thus, there was a highly skewed distribution of containers over distance from houses. To obtain a small number of distance classes with approximately equal numbers of collections, a logarithmic scale using four distance classes was based upon a 13× expansion, beginning at 0.5 (−1.70, 0.81, 1.93, . . . on the logarithmic scale) (Williams, 1964).

Data for species pairs were tested for positive or negative association by chi-square or Fisher’s exact test and by calculation of Cole’s (1949) coefficient of interspecific association (C_7), as described by Southwood (1966). Temperature and rainfall data were obtained from 19 weather stations scattered throughout the study area (NOAA, 1972). Changes in mosquito abundance during the study were examined for possible correlation with temperature and rainfall variations.

RESULTS

Twelve species of mosquitoes were collected during the study: *Aedes aegypti* (Linnaeus), *Ae. mediovittatus* (Coquillett),³ *Anopheles grabhamii* Theobald, *Culex antillummagnorum* Dyar, *Cx. atratus* Theobald, *Cx. habilitator* Dyar & Knab, *Cx. nigripalpus* Theobald, *Cx. p. quinquefasciatus* Say,⁴ *Cx. secutor* Theobald, *Toxorhynchites portoricensis* (Roeder), *Uranotaenia socialis* Theobald, and *Wyeomyia* sp. In addition, a chaoborid gnat (Diptera, Chaoboridae) was collected in rock hole habitats. Both the *Wyeomyia* and *Corethrella* spp. are apparently undescribed species (Belkin and Heinemann, 1975). Because the larval stages of chaoborids and culicids are morphologically and ecologically similar, the chaoborids are included within the Culicidae following Belkin *et al.* (1970).

Table 1 shows the number of positive and negative samples of different types. It was not always possible to determine distance to the nearest house, so that distance information was available for only 61% of the collections. Nearly all (97%) of the negative samples were scrapings from dry container habitats, mostly tree and rock holes. All negative samples were discarded from the analysis, since

³ Generic abbreviations for Culicidae follow Reinert (1975); *Co.* = *Corethrella*.

⁴ Sirivanakarn (1976) elevated *Cx. p. quinquefasciatus* to full specific status. I have elected to retain the subspecific designation for this taxon because elevation only serves to further confuse an already complex biosystematic problem.

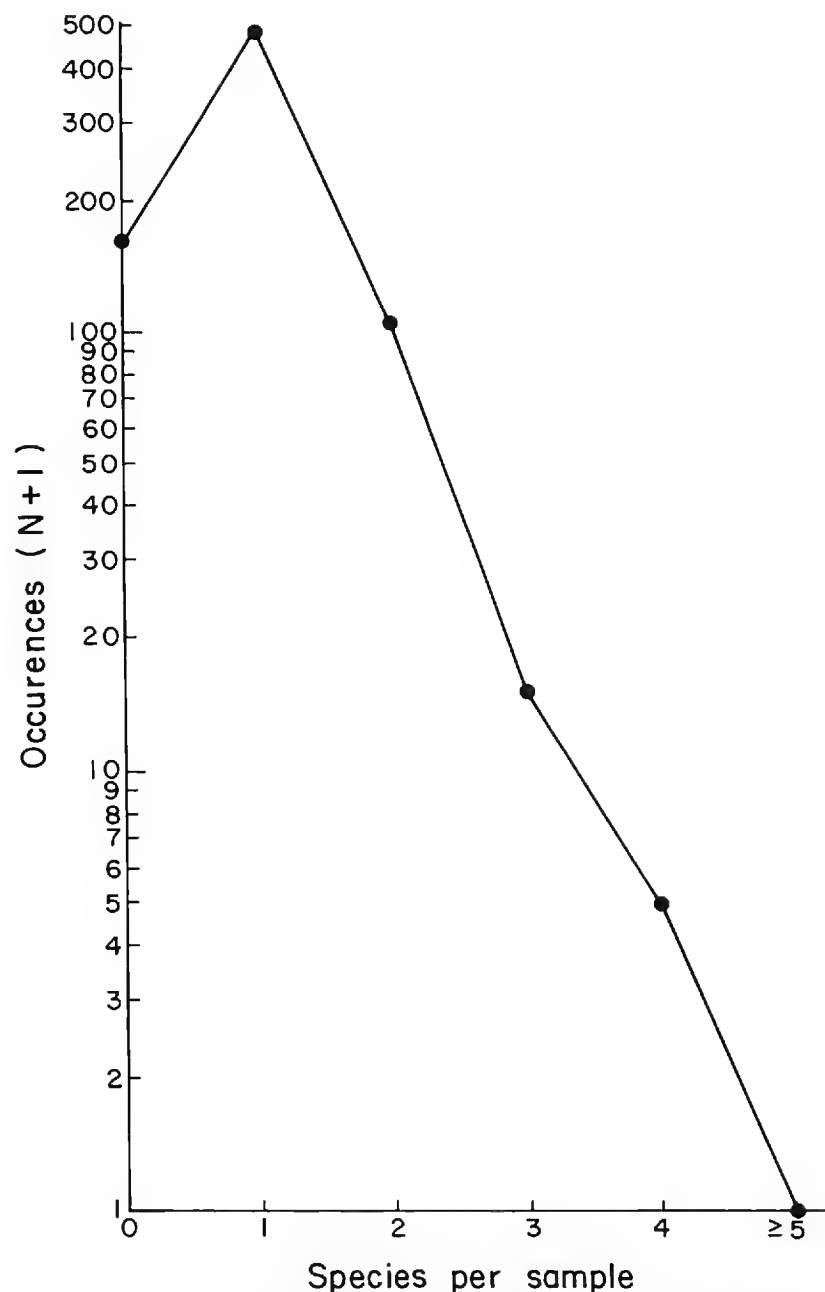


Fig. 2. Number of species per sample in 772 collections from various artificial and natural water-holding containers, western Puerto Rico, January-June 1971.

true negativity (absence of viable mosquito eggs) could not be differentiated from methodological problems in the hatching technique.

Distance from human habitation and species per sample.—Of the 160 negative samples, 155 were collections of material removed from dry containers while 5 were collections of water thought to contain larvae or pupae. Of 612 positive samples, 488 (79.7%) contained a single mosquito species, 106 (17.3%) contained 2, 14 (2.3%) contained 3, and 4 (0.7%) contained 4 species (Fig. 2). No sample contained more than 4 mosquito species.

The number of species per sample was related to proximity to houses. In the 383 positive larval/pupal collections of known distance, single species collections were more frequent near houses, while multi-species collections were more frequent away from houses. The relationship was significant ($P < 0.05$, chi-square), regardless of the geometric class intervals (i.e., 3×, 5×, 11×, 13×, 17×, 23×) used to group the collections (Williams, 1964).

Collections from containers less than 1 meter from houses (i.e., inside, attached to, or resting against the house) accounted for 34% of all positive collections. Over 50% of all positive collections were made within 4 meters of a house, and 96%

Table 2. Percent distribution of seven container-breeding mosquito species in relation to distance to nearest human residence, Puerto Rico (*n* = 383 samples).

Species	Distance from houses (meters)				Total samples
	<1	1-6	7-84	85-1098	
<i>Ae. aegypti</i>	44.0	37.0	18.1	0.8	243
<i>Ae. mediovittatus</i>	14.8	13.6	51.1	20.5	88
<i>Co. sp.</i>	0.0	10.7	42.9	46.4	28
<i>Cx. antillummagnorum</i>	6.7	26.7	33.3	33.3	15
<i>Cx. p. quinquefasciatus</i>	30.8	19.2	50.0	0.0	26
<i>Cx. secutor</i>	48.7	10.3	35.9	5.1	39
<i>Tx. portoricensis</i>	9.1	18.2	63.6	9.1	11
Samples per class	132	105	115	31	383

were no farther than 120 meters away from a house. In the areas under study, there were relatively few localities where houses were more than 240 meters apart.

Table 2 shows the distribution of the 7 most common species with respect to distance from houses. *Aedes aegypti* was most common near houses. *Aedes mediovittatus* was more common in collections away from houses, but nearly 30% of collections of this species were within 6 meters of a house. *Culex p. quinquefasciatus* and *Cx. secutor*, which share fairly similar container habitats, were somewhat similar in spatial distribution.

Importance of different kinds of container habitat.—Table 3 shows the relative importance of major container categories as breeding sites for the 7 most common mosquito species. Natural container habitats made up 23.8% (140/592) of all positive larval/pupal collections. Of those, 51.4% were rock holes, 32.1% were leaf axils, 7.1% were tree holes, and 9.3% were miscellaneous container types (snail shell, coconut shell, palm spathe, etc.). Because of the small numbers of collections from each container type, it was not possible to analyze the preference of a given species for specific kinds of natural containers.

Several species (e.g., *Ae. aegypti*, *Ae. mediovittatus*, *Cx. p. quinquefasciatus*, *Cx. secutor*) were broadly scattered among the different categories, while others (*Corethrella* sp., *Cx. antillummagnorum*) were highly selective and occurred only in a few kinds of container habitats. Several collections, such as *Cx. antillummagnorum* from rock holes, may be due to larvae being washed from a more common habitat into another habitat by heavy rain.

Culex secutor is primarily an inhabitant of pools in mountain streams (Belkin *et al.*, 1970), but as shown by these data, it has a broad range of larval habitats. It is also possible that the *Cx. secutor* of Puerto Rico consists of more than one species (Belkin *et al.*, 1970).

Zavortink (1972) recorded *Ae. mediovittatus* from all of the larval habitats shown in Table 3, plus ground pools, which were not sampled in this study.

The rock hole area previously studied by Fox *et al.* (1960) was located through the assistance of Mr. A. H. Boike. *Aedes aegypti* was still found breeding in the rock holes 12 years after their original survey. The rock hole area is located, as noted by Fox *et al.*, about 25 to 90 meters (80 to 300 ft) from the nearest houses. The area had been used as an unauthorized dump for some years, and by 1971, large numbers of artificial containers were present to serve as additional breeding

Table 3. Percent of breeding of 7 mosquito species in different container types, western Puerto Rico, 1971 (*n* = 592 samples positive for one or more species, adjusted for differing numbers of containers within types).

Species	Drum	Tire	Misc.		Rock hole	Misc. natural
			≥20 liters	<20 liters		
<i>Ae. aegypti</i>	29.7	22.7	13.0	17.7	7.8	9.1
<i>Ae. mediovittatus</i>	4.9	14.7	18.9	13.3	37.1	11.0
<i>Co. sp.</i>	0.0	2.2	8.2	3.1	86.5	0.0
<i>Cx. antillumagnorum</i>	0.0	4.1	7.1	10.3	5.0	73.4
<i>Cx. p. quinquefasciatus</i>	10.5	19.7	43.8	14.9	8.8	2.3
<i>Cx. secutor</i>	9.7	14.4	28.2	22.8	13.3	11.6
<i>Tx. portoricensis</i>	2.6	29.6	17.2	18.9	0.0	31.8
Total containers	178	87	50	137	72	68

sites. Fox *et al.* (1960) concluded that rock hole specimens of *Ae. aegypti* represented the spillover of oviposition due to population increases in other, more normal habitats, and no evidence was found in the present study to suggest otherwise. Additional coralline rock hole breeding sites were found near the town of Lajas.

Interspecific association.—Seven species were collected in sufficient numbers to permit calculation of Cole’s (1949) coefficient of interspecific association (*C*₇). *Aedes aegypti* was negatively associated with all of the other 6 species (Table 4). *Aedes mediovittatus* was positively associated with *Corethrella* sp. All other species pairings were random (i.e., species were not associated).

Sufficient data were available for *Ae. aegypti* and *Ae. mediovittatus* to compute *C*₇’s for either container type or distance from houses and, to a certain extent, for both factors simultaneously. There was a strong negative association between the species in terms of the type of container in which they occurred (Table 5). Table 3 shows the major differences in types of containers utilized. Water storage drums and tires were the most frequent sources of *Ae. aegypti*, while rock holes and miscellaneous large containers were the most frequent sources of *Ae. mediovittatus*. Joint occurrences of *Ae. aegypti* and *Ae. mediovittatus* were random with respect to distance from houses at 1–6 meters and 85–1098 m, but *C*₇’s were significantly negative at distances of less than 1 meter and from 7–84 meters (Table 5). Only 28 percent of all *Ae. mediovittatus* collections occurred within 6 meters of a house, while 81% of all *Ae. aegypti* were found within that distance (Table 3). Lack of significance in *C*₇’s at 1–6 and 85–1098 meters may have been due to small numbers of one species in these two distance categories, or even a zone of overlap in the 1- to 6-meter distance class.

Aedes aegypti and *Cx. p. quinquefasciatus*, both widely distributed domestic species, were negatively associated. The separation in this case appeared to be due to type of container and not to distance from houses. Most *Cx. p. quinquefasciatus* were found in tires and miscellaneous large containers (Table 4). Different preference for organic content of the container habitat probably also limits cohabitation.

Aedes mediovittatus and *Corethrella* sp., a predator, were positively associated (*C*₇ = 0.40 ± 0.10, Table 4), and *Ae. mediovittatus* may form a major part of the

Table 4. Coefficients of interspecific association (C_7 , Cole, 1949) between container-breeding mosquitoes in western Puerto Rico ($n = 383$ samples). $C_7 \pm SE$ significant (chi-square or Fisher's exact test) at $P \leq 0.05$ (*), 0.01 (**), or 0.001 (***). NS = non-significant (random) association between species.

	<i>Ae. mediovittatus</i>	<i>Co. sp.</i>	<i>Cx. antillum-</i> <i>magnorum</i>	<i>Cx. p. quinque-</i> <i>fasciatus</i>	<i>Cx. secutor</i>	<i>Tx. portoricensis</i>
<i>Ae. aegypti</i>	$-.71 \pm .07^{***}$	$-.89 \pm .14^{***}$	$-.89 \pm .19^{***}$	$-.48 \pm .14^{**}$	$-.68 \pm .12^{***}$	$-.71 \pm .22^{**}$
<i>Ae. mediovittatus</i>	—	$.40 \pm .10^{***}$	$-.13 \pm .46$ NS	$-.03 \pm .34$ NS	$.10 \pm .08$ NS	$-.60 \pm .54$ NS
<i>Co. sp.</i>	—	—	$-1.00 \pm .90$ NS	$-.49 \pm .66$ NS	$-.65 \pm .54$ NS	-1.00 ± 1.06 NS
<i>Cx. antillum-</i> <i>magnorum</i>	—	—	—	$-.05 \pm .92$ NS	$-1.00 \pm .75$ NS	-1.00 ± 1.47 NS
<i>Cx. p. quinque-</i> <i>fasciatus</i>	—	—	—	—	$-.27 \pm .55$ NS	-1.00 ± 1.08 NS
<i>Cx. secutor</i>	—	—	—	—	—	$.09 \pm .10$ NS

Table 5. Effect of container type and distance from houses on coefficient of association (C_7) between *Ae. aegypti* and *Ae. mediovittatus* in western Puerto Rico ($n = 383$ samples). $C_7 \pm SE$ significant (chi-square or Fisher's exact test) at $P \leq 0.05$ (*), 0.01 (**), or 0.001 (***). NS = non-significant (random) association.

Container type	Distance (m)				All distances
	<1	1-6	7-84	85-1098	
Large, artificial	$-.62 \pm .12^{***}$	1.00 ± 2.30 NS	$-1.00 \pm .40^*$	$-1.00 \pm .41$ NS	$-.66 \pm .08^{***}$
Small, artificial	$-.63 \pm .32$ NS	$-.40 \pm .16^*$	$-.69 \pm .26^*$	—	$-.61 \pm .15^{***}$
Natural	—	$-.23 \pm .49$ NS	$-.76 \pm .20^{***}$	—	$-.78 \pm .17^{***}$
All containers	$-.62 \pm .13^{***}$	$-.22 \pm .11$ NS	$-.77 \pm .15^{**}$	$-1.00 \pm .58$ NS	$-.71 \pm .07^{***}$

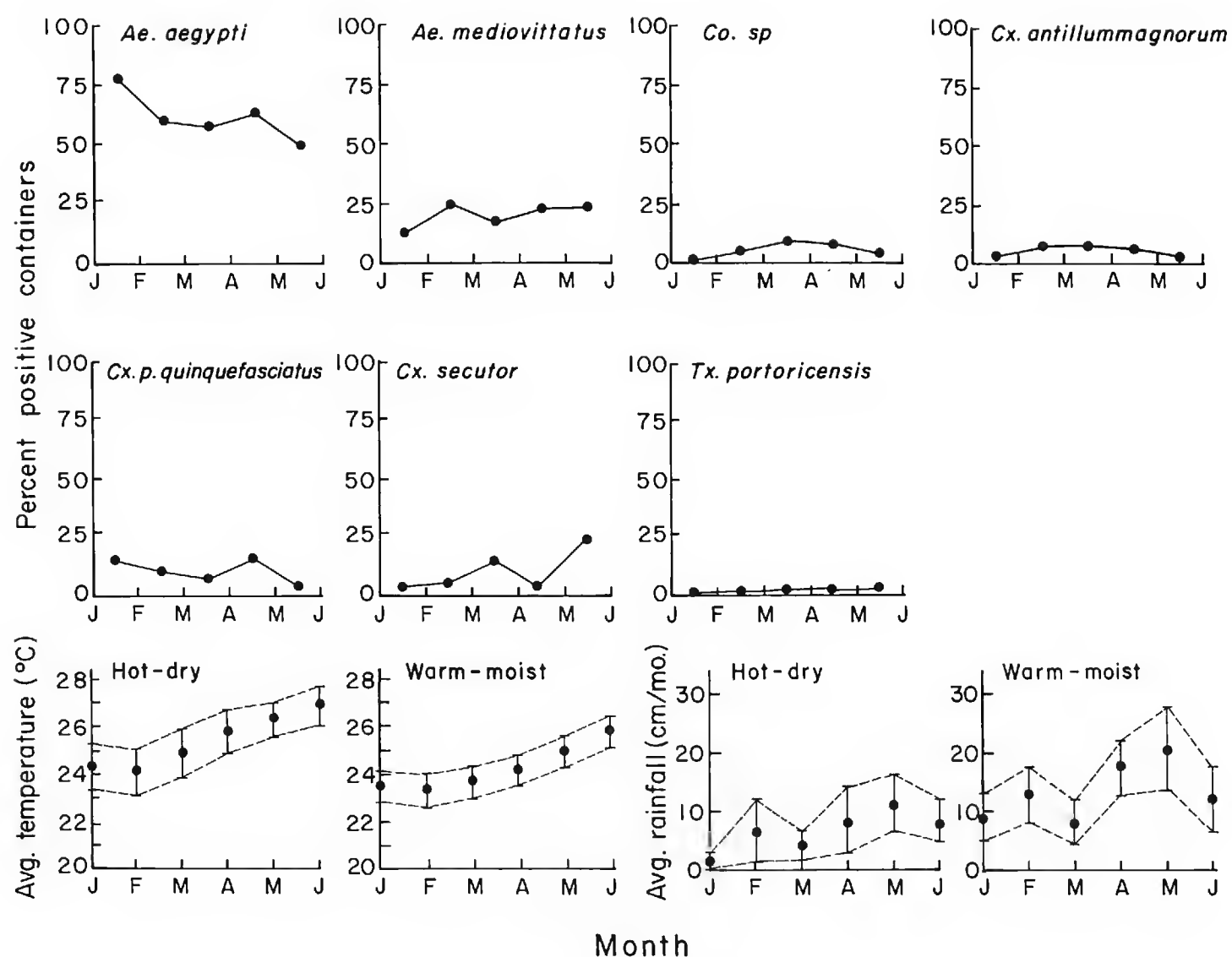


Fig. 3. Temperature, rainfall, and monthly abundance of container-breeding mosquito species in western Puerto Rico, January–June 1971 ($\bar{X} \pm \text{SD}$ shown for temperature and rainfall).

predator's diet. Moore and Haber (unpublished data) found that late instars of this *Corethrella* sp. consumed as many as 2.2 *Ae. mediovittatus* larvae per 24 h in laboratory experiments.

Weather pattern and temporal relationships between species.—The study area was not homogeneous with respect to temperature and rainfall. Average (January through June 1971) monthly temperature and rainfall for 11 stations in the study area fell into 4 distinct zones: a) hot-dry (26°C, 7 cm rain/month), b) warm-moist (24°C, 14 cm/month), c) cool-moist (21°C, 16 cm/month), and d) warm-wet (24°C, 21 cm/month). Approximately 95% of all collections came from the hot-dry or warm-moist zones.

January and February were the coolest months, and temperatures rose gradually and uniformly from March through June, when the study ended (Fig. 3). Rainfall was lowest in January. As is usual for the western part of Puerto Rico (Calvesbert, 1970), rainfall increased in February but was diminished again in March. Rainfall increased in April and May but was unusually low in June. June precipitation records were from 5 to 11 cm below normal for most parts of the island.

Some of the observed negative associations could have been due to temporal separation of population peaks, even though the study encompassed only a 6-month period (Fig. 3). Except for *Ae. aegypti* and *Cx. secutor*, the temporal occurrence of the species was fairly constant. There was a suggestion that several species may

have shown seasonal changes or shifts in utilization of different container types, but there were insufficient data to test that possibility. *Aedes aegypti* gradually declined in frequency over the course of the study. Although *aegypti* abundance appeared to be inversely related to environmental temperatures, island-wide studies by Moore *et al.* (1978) indicate that this is not the case. *Culex secutor* abundance was highly correlated with rainfall (Kendall rank correlation coefficient, $\tau = 0.71$, $P = 0.001$), with a lag effect of about 15 days.

DISCUSSION

There was no evidence of behavioral change in *Aedes aegypti* populations in western Puerto Rico as a result of the *Aedes aegypti* Eradication Program. Over 99% of all positive collections were made at distances of less than 85 meters from the nearest house, and no *Ae. aegypti* were found more than 100 m from houses. Similarly, natural container breeding sites made up only 17% of the total. Reports of unusual behavior (Fox *et al.*, 1960; Weinbren and Weinbren, 1970) were shown to be due to spillover from nearby domestic breeding sites or to transitory establishment following introduction of *Ae. aegypti* into an isolated focus of intense human activity (Haber and Moore, 1973).

Whenever *Aedes aegypti* has been introduced into new regions of the tropics, it has tended to displace the indigenous container-breeding *Aedes* of that region (Bailey and Bohart, 1952; Macdonald, 1956; Gilotra *et al.*, 1967; Chan *et al.*, 1971). Laboratory studies have similarly demonstrated the ability of *Ae. aegypti* to exclude other *Aedes* species (Wilton, 1968; Moore and Fisher, 1969; Peters *et al.*, 1969).

Aedes aegypti was probably introduced into Puerto Rico soon after the arrival of slaves from Africa in the early 16th century (Picó, 1969). Thus, *Ae. aegypti* has had more than 400 years and perhaps 5000 to 13,000 generations in which to evolve an optimal division of the container environment with local species.

The highly negative association between *Ae. aegypti* and the other major container-breeding species suggests that, if competitive displacement occurred, it did so some time ago. There appear to be major differences in oviposition sites (e.g., shade, organic content, pH), not measured in this study, that influence gravid females in selecting containers not attractive to *Ae. aegypti*. Conversely, *Ae. aegypti* seems able to utilize certain container habitats more effectively than can other species. This appears to be an example of an "included niche" (Schoener, 1974), as the other species have a broader niche than *Ae. aegypti* (either on the container type or distance axes, or both).

Additional studies are needed to clearly define the parameters that reduce or prevent competition among container-breeding mosquitoes. Some parameters that should be included in future studies are shade, height, density and species of surrounding vegetation; organic content (quality and quantity), pH, salinity, and source (rain or human activity) of the water; and orientation of the container. Future studies should also be carried on long enough to demonstrate any seasonal separation between species.

ACKNOWLEDGMENTS

This paper is dedicated to Dr. Richard M. Bohart who, with the late Dr. S. B. Freeborn, provided the resources and encouragement for my first mosquito ecol-

ogy studies. The late Dr. J. N. Belkin and the Mosquitoes of Middle America Project provided supplies for this study. The assistance of W. A. Haber, L. Acevedo, T. Feliberty-Ortiz, H. Nieves-Caro, C. Ortiz-Baez, W. Rodriguez and L. Bonilla-Navarro is gratefully acknowledged. I thank R. E. Bailey for advice on statistical analyses.

LITERATURE CITED

- Bailey, S. F., and R. M. Bohart. 1952. A mosquito survey and control program in Guam. *J. Econ. Ent.* 45:947-952.
- Belkin, J. N., and S. J. Heinemann. 1975. Collection records of the project "Mosquitoes of Middle America" 2. Puerto Rico (PR, PRA, PRX) and Virgin Is. (VI, VIA). *Mosq. System.* 7:269-296.
- Belkin, J. N., S. J. Heinemann, and W. A. Page. 1970. Mosquito studies (Diptera, Culicidae). XXI. The Culicidae of Jamaica. *Contr. Amer. Ent. Inst.* 6:1-458.
- Belkin, J. N., R. X. Schick, P. Galindo, and T. H. G. Aitken. 1965a. Mosquito studies (Diptera, Culicidae). I. A project for a systematic study of the mosquitoes of Middle America. *Contr. Amer. Ent. Inst.* 1(2):1-17.
- Belkin, J. N., C. L. Hogue, P. Galindo, T. H. G. Aitken, R. X. Schick, and W. A. Powder. 1965b. Mosquito studies. II. Methods for the collection, rearing and preservation of mosquitoes. *Contrib. Amer. Ent. Inst.* 1(2):19-78.
- Calvesbert, R. J. 1970. Climate of Puerto Rico and U.S. Virgin Islands. *Climatography of the United States*, No. 60-52. U.S. Dept. of Commerce.
- Chan, K. L., Y. C. Chan, and B. C. Ho. 1971. *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) in Singapore City. 4. Competition between species. *Bull. Wld. Hlth. Org.* 44:643-649.
- Cole, L. C. 1949. The measurement of interspecific association. *Ecology* 30:411-424.
- Fox, I., A. H. Boike, and I. Garcia-Moll. 1960. Notes on rock hole breeding and resistance of *Aedes aegypti* in Puerto Rico. *Amer. J. Trop. Med. Hyg.* 9:425-429.
- Gilotra, S. K., L. E. Rozeboom, and N. C. Bhattacharya. 1967. Observations on possible competitive displacement between populations of *Aedes aegypti* Linnaeus and *Aedes albopictus* Skuse in Calcutta. *Bull. Wld. Hlth. Org.* 37:437-446.
- Haber, W. A., and C. G. Moore. 1973. *Aedes aegypti* in the Puerto Rican rain forest: Results of a one-year survey. *Mosq. News* 33:576-578.
- Kellett, F. R. S., and T. A. Omardeen. 1957. Tree-hole breeding of *Aedes aegypti* (Linn.) in Arima, Trinidad. *B. W. I. W. Ind. Med. J.* 6:179-188.
- Likosky, W. H., C. H. Calisher, A. L. Michelson, R. Correa-Coronas, B. E. Henderson, and R. A. Feldman. 1973. An epidemiologic study of dengue type 2 in Puerto Rico, 1969. *Amer. J. Epidemiol.* 97:264-275.
- Macdonald, W. W. 1956. *Aedes aegypti* in Malaya. I. Distribution and dispersal. *Ann. Trop. Med. Parasit.* 50:385-398.
- McClelland, G. A. H. 1967. Problems of interaction and density in mosquitoes in relation to *Aedes aegypti* eradication. *Proc. Calif. Mosq. Contr. Assoc.* 35:94-95.
- Moore, C. G. 1977. Insecticide avoidance by ovipositing *Aedes aegypti*. *Mosq. News* 37:291-293.
- Moore, C. G., B. L. Cline, E. Ruiz-Tiben, D. Lee, H. Romney-Joseph, and E. Rivera-Correa. 1978. *Aedes aegypti* in Puerto Rico: Environmental determinants of larval abundance and relation to dengue virus transmission. *Amer. J. Trop. Med. Hyg.* 27:1225-1231.
- Moore, C. G., and B. R. Fisher. 1969. Competition in mosquitoes. Density and species ratio effects on growth, mortality, fecundity, and production of growth retardant. *Ann. Ent. Soc. Amer.* 62:1325-1331.
- National Oceanic and Atmospheric Administration. 1972. Climatological data. Puerto Rico and Virgin Islands. 17(1-12):1-152.
- Neff, J. M., L. Morris, R. Gonzalez-Alcover, P. H. Coleman, S. B. Lyss, and H. Negron. 1967. Dengue fever in a Puerto Rican community. *Amer. J. Epidemiol.* 86:162-184.
- Peters, T. M., B. I. Chevone, and R. A. Callahan. 1969. Interactions between larvae of *Aedes aegypti* (L.) and *Culex pipiens* L. in mixed experimental populations. *Mosq. News* 29:435-438.
- Picó, R. 1969. Nueva Geografía de Puerto Rico. Editorial Universitaria, Univ. de P.R., Rio Piedras, 460 pp.

- Reinert, J. F. 1975. Mosquito generic and subgeneric abbreviations (Diptera: Culicidae). *Mosq. System.* 7:105-110.
- Schoener, T. W. 1974. Resource partitioning in ecological communities. *Science* 185:27-39.
- Sirivanakarn, S. 1976. Medical entomology studies. III. A revision of the subgenus *Culex* in the Oriental Region (Diptera: Culicidae). *Contr. Amer. Ent. Inst.* 12(2):1-272, illus.
- Southwood, T. R. E. 1966. Ecological methods. Methuen and Co., London, 391 pp.
- Von Allmen, S. D., R. H. Lopez-Correa, J. P. Woodall, D. M. Morens, J. Chiriboga, and A. Casta-Velez. 1979. Epidemic dengue fever in Puerto Rico, 1977: a cost analysis. *Amer. J. Trop. Med. Hyg.* 28:1040-1044.
- Weinbren, M. P., and A. K. O'Gower. 1966. A simple artificial tree hole for recovering mosquito eggs, with a note on the recovery of *Aedes aegypti* eggs from rain forests in Puerto Rico. *Mosq. News* 26:522-526.
- Weinbren, M. P., and B. M. Weinbren. 1970. Observations on the mosquito population in the irradiated forest at El Verde. Ch. E-12. *In*: H. T. Odum and R. F. Pigeon, eds., *A tropical rain forest*. U.S. Atomic Energy Commission, Washington, D.C.
- Williams, C. B. 1964. Patterns in the balance of nature. Acad. Press, New York, 324 pp.
- Wilton, D. P. 1968. A laboratory study of larval competition between *Aedes aegypti* (L.) and *Aedes triseriatus* (Say). *Mosq. News* 28:627-630.
- Zavortink, T. J. 1972. Mosquito studies (Diptera, Culicidae). XXVIII. The new world species formerly placed in *Aedes* (*Finlaya*). *Contr. Amer. Ent. Inst.* 8(3):1-206.

A New *Perdita* from Utah's San Rafael Desert (Hymenoptera: Andrenidae)

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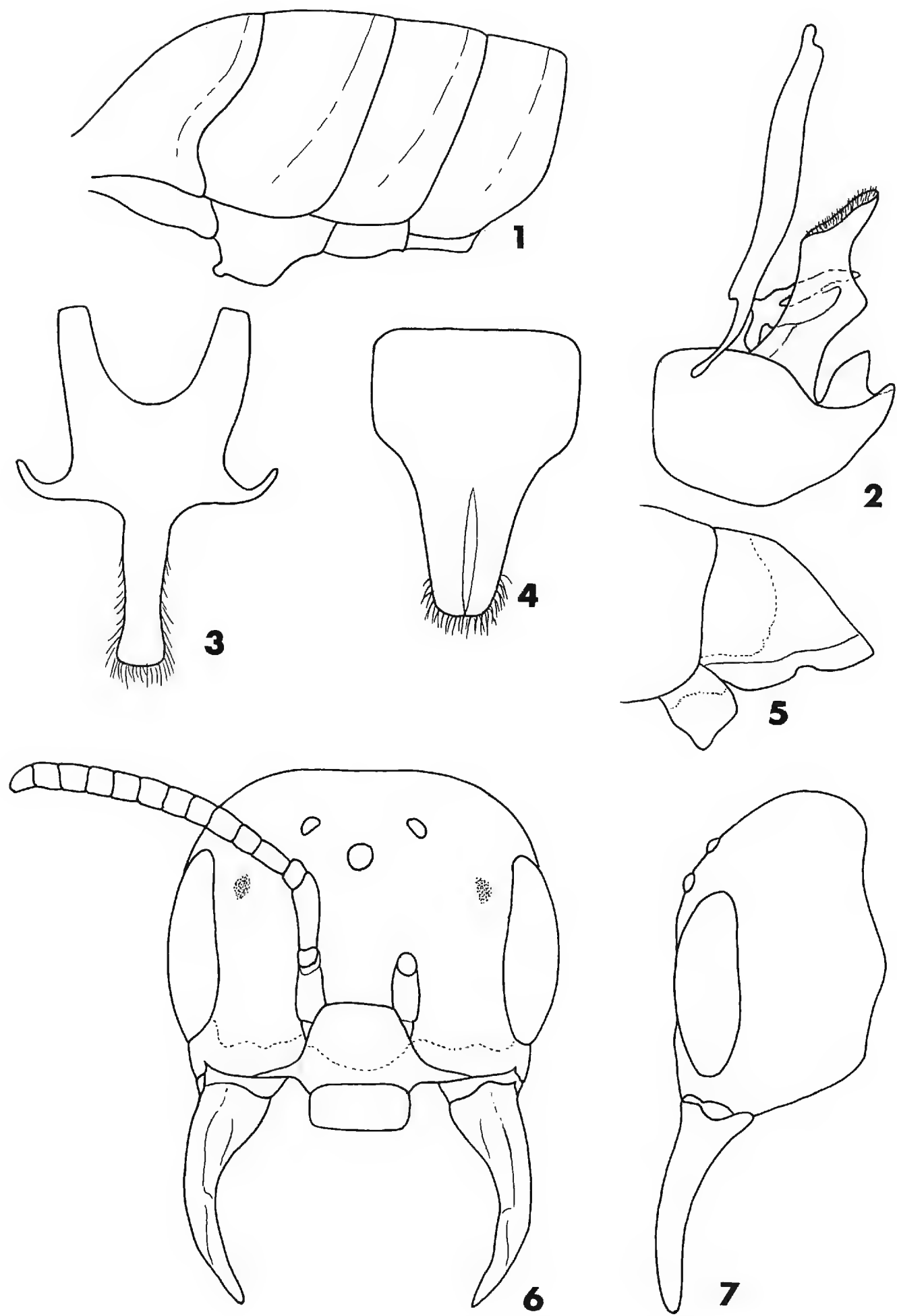
Bees of the genus *Perdita* are a large and diversified assemblage of species that are principally western North American in distribution. The number of species and subspecies described is well over 600, and most of our knowledge of *Perdita* has been through the important papers of P. H. Timberlake, now deceased. Many of our native flowering shrubs and forbs have one or more species of *Perdita* associated in some manner with the plant. For most species of *Perdita*, however, the nature of this bee-plant relationship has not been investigated. Perhaps their small size (most species are 2-4 mm long) has contributed to the lack of pollination studies of this interesting group of bees.

The systematics of *Perdita* is not easily understood because the genus is speciose, and the existing keys are difficult to use without a representative collection for comparisons. Although there are a number of unnamed *Perdita* in our collection, I am describing here only one, a rather bizarre species that was recently collected in southern Utah. This new bee is easily separable from all known *Perdita* by its unusually large size (10 mm) and sternal modifications.

This *Perdita* was collected in a 2500²-mile Utah desert that has been almost completely isolated by surrounding mountains since the late Pliocene (Hunt, 1974), and which has more endemic plant species than any other area in the Intermountain Region (Cronquist *et al.*, 1972).

Perdita bohartorum Parker, NEW SPECIES (Figs. 1-7)

Holotype male.—Black; head, thorax dark blue-green; scutum, scutellum with coppery reflections; orange-red on mandible apex, mouth parts, apical margin of tergum 7; yellowish markings on mandible, labrum, clypeus, laterally on supra-clypeal area, beneath antenna, stripes laterally on crest of pronotum, pronotal lobe except medially, forefemoral apex, anterior stripe on fore and midtibiae; tergum 1 with only lateral stripe, terga 2-6 with lateral and apical stripes that become wider on apical terga, tergum 7 all yellow, sterna 1-7 mostly yellow except basally; tegula hyaline, wings hyaline, veins white; forebasitarsus whitish. Pubescence white, not dense on head, thorax; subapical thin hair band on sterna, terga. Punctuation on body not uniform; head mostly shiny with punctures separated by more than their diameter, surface polished, upper frons, behind interocellar area dull; punctures closer on thorax and legs but surface shiny; microstriae medially on dorsal surface of propodeum; abdomen shiny with shallow punctures. Clypeus with median truncation ($\frac{1}{3}$ width of clypeus); mandibles as long as width of clypeus, tapering to point; labrum twice as wide as long, small; mouthparts extending beyond forecoxae in repose; galea 1.6 $\times$ longer than labrum; maxillary



Figs. 1–7. *Perdita bohartorum*. 1, Lateral view of male abdominal segments 1–4. 2, Lateral view of genital capsule. 3, Male sternum 8. 4, Male tergum 8. 5, Lateral view of male tergum and sternum 7. 6, 7, Male head; 6, Front view; 7, Lateral view.

palpal segments of equal length; basal labial palpal segment 4× longer than apical ones; hypostomal carina raised flange-like; head measurements as follows: wider (1.2×) than long (Fig. 6); antennocular distance 1.1× wider than interantennal distance; distance between median ocellus and antennal base shorter than distance from median ocellus to hind margin of vertex (1.5×); distance between lateral ocelli equal to ocellocular distance; distance between lateral ocelli greater (2.5×) than distance between median and lateral ocelli; distance between ocular and hind margin of vertex greater (1.4×) than ocellocular distance; postocular area (Fig. 7) wider (2×) than width of eye; malar space as wide as diameter of median ocellus; clypeus not protuberant in lateral profile; antenna nearly as long as length of eye; flagellomeres I, XI 1.4× longer than other flagellomeres, I somewhat flattened; scape short, as wide as 2nd submarginal cell; facial fovea small, oval, about size of median ocellus; hindfemur 5× as long as wide, hindtibia about 9× as long as wide; hindbasitarsus 6× as long as wide; fore, midlegs shorter; hindtrochanter normal; pronotum laterally with wide, flat depression, collar slightly indented medially, rounded laterally; scutum 1.2× wider than long, scutellum as long as horizontal area of propodeum, 1.3× wider than metanotum; 1st submarginal cell slightly longer (1.1×) than marginal cell; mesopleuron without sulcus connecting subalar pit and base of wings; abdomen slightly wider 1.05× than thorax; broad hyaline band apically on terga, sterna, band wider than length of subapical hair band; sternum 1 with shallow median longitudinal groove, sternum 2 with prominent U-shaped, keel-like median projection (Fig. 1); sterna 3-5 with lateral low swellings forming shallow median basin; sternum 7 with median notch; sternum 8 (Fig. 3); tergum 7 with lateral U-shaped notch (Fig. 5); tergum 8 (Fig. 4); genitalia as in Fig. 2; length 10 mm.

Female.—Like male except: head, propodeum with coppery reflection; mandible black; terga 2-5 mostly yellow, black apically, basally on some; pubescence on tergum 5 long, covering most of segment; scopal hairs on hind legs sinuate, as long as forebasitarsus; terga 3-5 with white patch of bristles ventrolaterally; clypeus longer, extending just beyond base of mandible; protuberant in lateral profile; mandible bent apically; face more oval; inner eye margins converging below; closed mandible nearly attaining opposite mandibular base; facial fovea narrow, nearly touching inner margin of eye, extending just beyond mid length of eye, as wide as antennal base; distance between median ocellus and antennal base equal to distance from median ocellus to hind margin of vertex; distance between lateral ocelli greater (1.3×) than ocellocular distance; distance between ocular and hind margin of vertex equal to ocellocular distance; postocular area slightly wider than width of compound eye; malar space narrower; antenna longer than eye; segments of hindleg shorter; sterna without projections; pygidium long, apically truncate.

Variation.—Only subtle differences exist in the markings, punctuation and structure of the paratypes.

Systematics.—I have not assigned this peculiar *Perdita* to any of the existing species groups or subgenera. In some characters it appears to be related to species in both of the subgenera *Cockerellia* and *Procockerellia*, but major differences are evident. For example, *P. bohartorum* has a wide malar space, long galea, flat clypeal area, and prominent swellings on the sterna. Species of *Cockerellia* lack

a malar space, the galea is shorter, the clypeus of the males is protuberant in profile and the abdomen lacks sternal projections. However, species of *Procockerellia* have similar pubescence and long mouthparts. One ponders the function of the distinctive sternal swellings since no other described species in this genus has such abdominal modifications.

Types.—Holotype ♂ and 11 ♂ paratypes: UTAH: *Emery Co.*, sandy ridge E. of Little Gilson Butte, 5100', May 29, 1981 (F. D. Parker, S. F. Parker). Holotype deposited in the U.S. National Museum #100071. Metatypes, 21 ♂ and 7 ♀ (3 mating pairs), same data except: June 3, 1982 (F. D., J. H., S. F., and A. D. Parker, T. L. Griswold).

Floral records.—All specimens were collected on flower heads of *Wyethia scabra* Hook. This composite is a multiflowered perennial found on hill tops and ridges in southern Utah, adjacent New Mexico and Arizona. The bees were collected during the afternoon (1–3:30 p.m.). Males were resting or flying around the flower heads and females were observed collecting pollen. This species was found only at the type location; large patches of the host plant, even within 0.5 km of the type locality, had no bees at the flowers. In both 1981 and 1982 we examined many *Wyethia* plants at several other locations without finding additional populations of this *Perdita*.

Predator.—A female of *Philanthus pulcher* D.T. was netted after she had captured a male of *P. bohartorum* on a *Wyethia* flower head.

Etymology.—It is a pleasure to name this distinctive bee after the brothers Bohart who have contributed so much to our present day knowledge of the systematics and biology of Hymenoptera. Richard was my major advisor during my graduate years at Davis, and George (Ned) was my “boss” and now is a colleague in the bee lab at Logan, Utah.

LITERATURE CITED

- Cronquist, A., A. H. Holmgren, N. H. Holmgren, and J. L. Reveal. 1972. Intermountain flora. Vol. 1. Hafner Publ. Co., New York, 270 pp.
Hunt, C. B. 1974. Natural regions of the United States and Canada. W. H. Freeman and Co., San Francisco, 725 pp.

Expanding Geographical and Ecological Range of *Platynota stultana* in California (Lepidoptera: Tortricidae)

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The moth that later became known to American economic entomologists as the "omnivorous leaf-roller," *Platynota stultana* (Walsingham), was described from specimens collected by H. K. Morrison in the "Province of Sonora," Mexico (Walsingham, 1884). Probably the locality was near the international border because Morrison's biographers state that he worked in Arizona during 1881 and New Mexico in 1882 (Mann, 1885), or 1882 and 1883 in Arizona (Smith, 1885), but they do not mention Mexico among his expeditions. The species was collected in what is now Cochise County in southeastern Arizona in the 1890's by F. H. Snow (AMNH, CU, KU)¹ and in Sinaloa, Mexico, as early as 1893 (USNM), so the native range probably included semiarid parts of northwestern mainland Mexico and adjacent southwestern United States.

As the common name implies, a broad array of larval hostplants is known. Atkins *et al.* (1957) summarized records representing about 20 families of Angiospermae, most of which arose from urban and agricultural situations, whence the insect has expanded its geographical range during the past 80 years. *Platynota stultana* evidently was not native in cismontane southern California, because it was not encountered in the early years of citrus investigations, during the 1880's and 1890's, yet it became a conspicuous pest by 1913-1915 (Woglum, 1920).

HISTORY OF OCCURRENCE IN CALIFORNIA

Data associated with specimens examined (see acknowledgments) and in the files of the California State Department of Food and Agriculture indicate the following history of introduction and spread within the state.

The earliest records I have seen are in Los Angeles County, 1898 at La Mirada and 1904 at Los Angeles (USNM). Had the species been native in the vicinity of southern California towns, it certainly would have been encountered by Coquillett, who reared and collected many microlepidoptera during 1883-1892 in the Los Angeles area. As a comparison, there are a number of 1880's records for the orange tortrix, *Argyrotaenia citrana* (Fernald), a moth with similar larval and adult habits and life history (Powell, 1964). By 1913-1915, however, *P. stultana* had become an economic problem in several citrus and cut flower growing areas of Los Angeles and Orange counties (Woglum, 1920; Bohart, 1942). Other early collections of *P. stultana* include occurrences at San Diego, 1913 (SDNH), Needles on the Colorado River, 1918 (CU), and San Bernardino by 1925. The species also expanded southward, into Baja California, having been taken at Ensenada, in 1941 (USNM).

¹ See acknowledgments for list of institutional abbreviations.

Northward, *P. stultana* was taken at Saticoy, Ventura County, in 1925 (USNM), and it reached coastal Santa Barbara County by 1940, although the date of initial establishment and continuous residency there is unknown. There is a record for Carpinteria in 1940 (CDFA), and *P. stultana* was reared from larvae during the Channel Islands Biological Survey, on Anacapa Island, the same year (LACM). The species evidently did not continue its northward expansion along the coast, as there are no records north of Santa Barbara in field situations during the subsequent 20 years.

Once established in southern California, a diversity of ornamental and agricultural plants was adopted. Records include tomato (*Lysopersicon*) (1898); *Portulaca* (1904); *Citrus* and carnation (*Dianthus*) (1913); avocado (*Persea*) and walnut husks (*Juglans*) (1925); pepper pods (*Capsicum*) (1926); pigweed (*Chenopodium*) and *Malva* (1929); youngberries (*Rubus*) (1932); sugar beet (*Beta*) and *Cyclamen* (1934) (USNM records). There were many interceptions of larvae in bell peppers from Sinaloa at Nogales and Los Angeles during the late 1920's and 1930's, resulting in a federal quarantine (Busck, 1933).

By contrast, there are few records of *P. stultana* on native plants. Goeden and Ricker (1976a,b) encountered the species on native ragweeds (*Ambrosia*) in desert areas and in roadside, abandoned cropland, and other artificial expansions of *Ambrosia* habitat in cismontane southern California. Also in the 1970's, the species was reared by Gorelick from *Eriogonum grande* Greene, an insular endemic plant, on Santa Catalina Island (CIS).

There are specimens from Sacramento reared in 1932 from alfalfa, and in nursery situations during 1943–1945 (CDFA), but it appears that populations have not been established continuously in the Sacramento Valley, because there are no records for field situations between 1932 and 1955. Similarly, the omnivorous leaf-roller was recorded in greenhouses in the San Francisco Bay area in 1940–1941 (Bohart, 1942); at Salinas, Monterey County, in 1955 (CDFA); and in Alameda County at San Leandro (1957) (CDFA). However, prior to 1955, there are no confirmed records of *P. stultana* established in the field anywhere north of the Transverse Range, which separates cismontane southern California from the rest of the state.

In the late 1950's and during the following several years, populations of this insect greatly expanded their geographic and ecological ranges in California. The data suggest that changes in physiological tolerance developed in relation to physical factors.

In 1956 adults of *P. stultana* were taken at lights in urban Davis, Yolo County (20 km west of Sacramento) (CIS). Although I did not encounter the species during three months' sampling in Kern County in 1955, it appeared in agricultural field situations there in 1959, in a light trap at Bakersfield in July (CIS), and feeding on cotton flowers and fruit at Edison (10 km ESE of Bakersfield) in August (CDFA). The following year *P. stultana* was taken on cotton at McFarland (40 km NNW of Bakersfield), and during 1961–1963, the omnivorous leaf-roller quickly spread throughout the San Joaquin and southern Sacramento valleys (Map 1). It acquired considerable notoriety as a new pest of vineyards, beginning in 1963 (Lynn, 1969; Ali Niazee and Stafford, 1972).

Platynota stultana reached the Monterey Bay area and inner Contra Costa County (Antioch) by 1967 and Glenn County in the northern Sacramento Valley

by 1968 (CIS, CDFA). Although there had been sporadic nursery and greenhouse records in the San Francisco Bay area for more than 25 years, *P. stultana* was not recorded out of doors until 1967, when it was reared from potted *Senecio* at Albany, Alameda County (Frick and Hawkes, 1970; CIS). Adults first appeared at lights in 1979, when they were collected in Berkeley (CIS). Its late establishment on Santa Cruz Island, in the mid 1970's (Powell, 1981) is postulated to be the result of introduction by man following broader ecological adaptation by populations of adjacent mainland areas, where *P. stultana* apparently was localized and was rarely encountered during the 1940's and 1950's.

INCREASED DIVERSITY OF LARVAL HOSTPLANTS

In the process of the 1960's expansion, *P. stultana* adapted to a wider diversity of plants, including conifers and both dicotyledons and monocotyledons, a much greater taxonomic array featuring more diverse chemical and physical characteristics, than the herbaceous angiosperms adopted in southern California during the early part of the century. Thus, the physiological tolerance by *P. stultana* expanded to encompass gymnosperms, including Pinaceae (*Pinus*) (Yolo Co., 1966), Cupressaceae (*Juniperus*) (Fresno Co., 1966), and Taxaceae (*Taxus*) (Monterey Co., 1967); monocotyledons, Poaceae, including *Zea* (Tulare Co., 1963 and Kern Co., 1969), *Sorghum* seed (Glenn Co., 1969); various additional legumes, including *Phaseolus* (Stanislaus Co., 1961), *Albizia* (Kings Co., 1964), and *Arachis* (Fresno Co., 1966); as well as Vitaceae and exotic representatives of many plant families, such as Begoniaceae, Celastraceae, Aquifoliaceae, Theaceae, Aizoaceae, Ginkgoaceae, and Ebenaceae (CDFA records), additional to host records summarized by Atkins *et al.* (1957).

Conifers, monocotyledons and legumes are kinds of plants generally used by microlepidoptera that are specialized in terms of larval foods (Powell, 1980), and none of these hosts had been recorded as a foodplant of *P. stultana* in California prior to 1950. There is some indication that expanded host selection has taken place in southern California populations as well, for example use of *Ginkgo* (1961), *Juniperus* (1970), and *Trifolium* (1971) in Santa Barbara County (CDFA).

Whether physiological tolerance to physical factors such as high rainfall, low temperature winters also broadened is problematic. There are early records for desert areas, e.g., Needles (1918); Yuma (1925, 1928); and in San Diego County at San Felipe Wash (1935) and Borrego (1941) (AMNH, USNM), indicating that survival in arid climatic situations of extreme temperature ranges occurred. Nonetheless, range expansion of field populations into northern California seemed to take place contemporaneously with broader hostplant use.

DISCUSSION

Inconsistencies of sampling notwithstanding, it seems apparent that after colonization around the turn of the century, *Platynota stultana* became widely established and adapted in southern California during the following 20 years, remained stable for another 30 years, then expanded its range in a relatively short time to encompass low elevation areas in most of the rest of the state. The maximum area (greatest right-angle, straight line distances) occupied in California during 1915-1950, some 80,000 square km, more than tripled, to ca. 270,000 square km, during 1956-1968, with an increase in latitudinal range from 1°45'

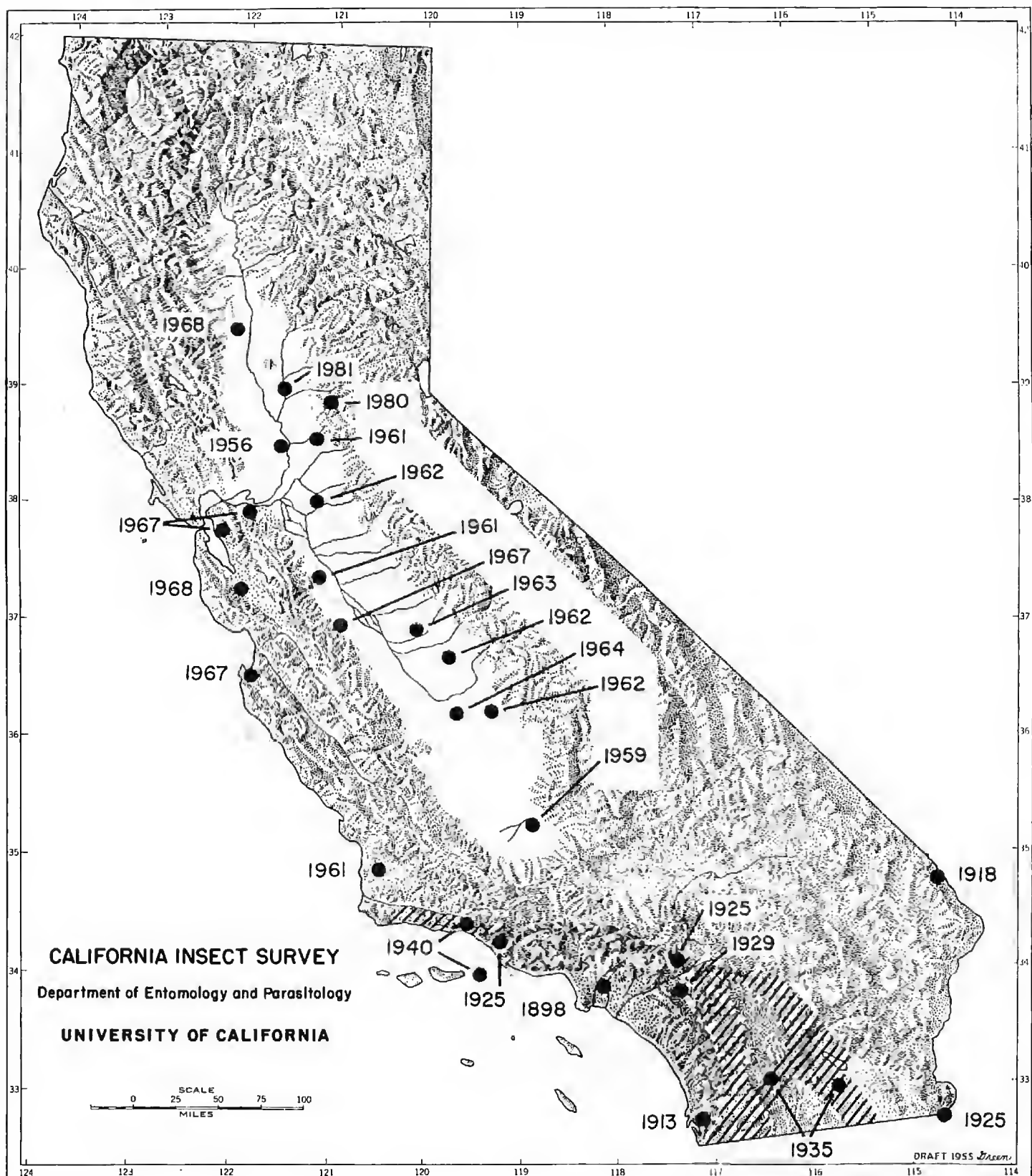


Fig. 1. Geographical distribution of *Platynota stultana* in California: by 1925 (dark shading); additional areas known to be inhabited by 1940 (cross hatched); later dated localities refer to first records in counties north of the Transverse Ranges.

to $6^{\circ}45'$ (Fig. 1). At the same time there was adaptation to a considerably greater spectrum of environmental conditions, particularly larval foods, shorter frost-free season, and increased total precipitation.

A similar kind of range expansion, establishment followed by gradual encroachment in a restricted area for a long time, then rapid enlargement of the area occupied, has been observed for other introduced insects. For example, the European skipper butterfly, *Thymelicus lineola* (Ochsenheimer), was discovered in southern Ontario in 1910. Its early progress is poorly documented, but because

butterflies are the best surveyed group of insects and because this species is a pest of Timothy grass, the progress of its distribution in later years could be reconstructed with reasonable confidence (Burns, 1966). From 1910 to 1950 the range did not enlarge much, southwestward as far as Findlay in northern Ohio (1927) and the vicinity of Ann Arbor, Michigan (1949), and northeastward to Toronto (1945) and Niagara Falls (1948), a maximum range of ca. 46,000 square km. Suddenly, during 1953-1965, records from widely scattered areas appeared, indicating that populations had expanded in all directions, to encompass most of the northeastern U.S. and adjacent parts of Canada, from New Brunswick west to Lake Superior and south to Maryland, a maximum area of ca. 1.5 million square km. In addition, a colony was discovered in British Columbia, which may have resulted from an independent introduction from Eurasia or via railroad from the east (Burns, 1966).

It is probable that saltatorial range expansions following a period of slow progress by colonist species often are masked by inadequate documentation of the history of spread, or even that such bursts might appear to have occurred because of gaps in the record. Thus, the Old World earwig, *Euborellia annulipes* (Lucas) seems to have undergone a history in California similar to that of *Platynota stultana*; i.e., widespread establishment in southern California and at coastal stations northward, from 1880 (and probably much earlier) to the 1920's, then a rapid expansion during 1932-1941, in which the Central Valley, Coachella Valley, and Colorado River areas were occupied (Langston and Powell, 1975). By contrast, an apparent accelerated expansion of the European tortricid moth, *Croesia forskåleana* (L.) in the northeastern U.S., was interpreted to be an artifact of lack of effort by resident collectors (Powell and Burns, 1971). In both examples early collection records are sporadic, however, and precise details of the range extensions cannot be retraced.

The best documentation of insect introductions and subsequent spread have come from examples of classical biological control. DeBach (1965) summarized criteria of colonization and pointed out that only ca. 20-25% of attempted introductions have resulted in successful establishment and then complete preadaptation to the new environment usually seems to have been the rule. DeBach discussed two possible cases of latent increase in adaptive fitness in entomophagous insects. In one, *Comperiella bifasciata* Howard (Aphelinidae), large releases of progeny from a small founder colony (5 mated females) were made in various parts of southern California in 1942. By 1946 it was apparent that establishment was successful only at Riverside. During 1948-1957, however, the colonist populations spread westward and southward to inland districts of Los Angeles and San Diego counties and continued to increase in abundance during the next several years.

On theoretical evolutionary grounds, the most plausible explanation of delayed ecogeographical expansions by introduced insects is one of increased genetic fitness to environmental conditions in areas peripheral to the new home. It is generally believed that introductions often consist of few founders. When their genetic preadaptation sufficiently meets physical and biotic demands of the environment at the place of introduction, colonization may be successful, often with establishment aided by release from biotic population controls in source populations. This sets the stage for possible acceleration of evolutionary change. Selection pressure

at the margins of expanding founder populations may promote increased physiological adaptedness to environmental situations to which the founders, or even the source populations, were not preadapted.

DeBach (1965) warned that observed long-term changes in distribution and abundance of introduced species may be due to ecological factors rather than genetic change. In particular, as demonstrated by population trends in several aphelinid parasitoids of scale insects in California, competitive displacement either by later arriving introduced species or by competitors already established, may comprise an important, though cryptic influence affecting changes in populations. Thus, for example, before assuming that increase in the distribution of *Thymelicus lineola* was due to genetic change, we should consider whether ecological factors, especially competition with native species of grass-eating Hesperinae, might have been involved. It would be interesting to search for changes in relative abundance or distribution of native hesperiine species in the Great Lakes-Northeastern U.S. region since 1950, and in changes in host grass selection by *T. lineola*.

By contrast, competitive displacement seems less likely in phytophagous, holometabolous species that are polyphagous as larvae, or in general feeders and scavengers such as earwigs. Certainly it would be much more difficult to document than in examples of closely related, specific feeders occupying similar niches to one another. If altered genetic fitness is responsible for latent bursts of expansion, the humbers of generations required presumably would vary widely with differing selective regimes. On the average, for a univoltine insect such as *Thymelicus*, a considerably longer period might be expected (e.g., 40–50 years), than for a homodynamic species such as *Comperiella* or *Platynota* with several annual generations (e.g., 5–20 years).

ACKNOWLEDGMENTS

Collection data for early records were compiled by the late R. L. Lambert, Ottawa, Canada, although I have reexamined most of the specimens. T. D. Eichlin, California State Department of Food and Agriculture, Sacramento, provided copies of all collection records for California counties north of Santa Barbara, many of which are not represented by extant specimens. G. A. Gorelick provided specimens from Santa Catalina Island. Cooperation by authorities of institutional collections enabled study of specimens in their care: ANMH—American Museum of Natural History, New York; CDFA—California Department of Food and Agriculture, Sacramento; CIS—California Insect Survey, University of California, Berkeley; CU—Cornell University, Ithaca, New York; KU—Snow Entomological Museum, University of Kansas, Lawrence; LACM—Los Angeles County Museum of Natural History, Los Angeles; SDNH—San Diego Natural History Museum, San Diego, California; USNM—U.S. National Museum of Natural History, Washington, D.C.

DEDICATION

This paper is dedicated to Prof. R. M. Bohart in commemoration of his long and remarkably productive career, which included early work with *Platynota stultana* and other California microlepidoptera. Twenty-nine years ago Bohart and I participated in the University of California summer field course in Entomology, his initiation as an instructor and mine as a student. No doubt he re-

covered from the experience in a few years, but I never did, for my attention had been irrevocably turned from large to small insects, the really "innersting" ones.

LITERATURE CITED

- Ali Niaze, M. T., and E. M. Stafford. 1972. Notes on the biology, ecology, and damage of *Platynota stultana* on grapes. J. Econ. Ent. 65:1042-1044.
- Atkins, E. L. Jr., M. H. Frost, Jr., L. D. Anderson, and A. S. Deal. 1957. The "omnivorous leaf roller", *Platynota stultana* Wlsh., on cotton in California: Nomenclature, life history, and bionomics (Lepidoptera, Tortricidae). Ann. Ent. Soc. Amer. 50:251-259.
- Bohart, R. M. 1942. *Platynota stultana* as a pest of field-grown carnations. J. Econ. Ent. 35:399-403.
- Burns, J. M. 1966. Expanding distribution and evolutionary potential of *Thymelicus lineola* (Lepidoptera: Hesperidae), an introduced skipper, with special reference to its appearance in British Columbia. Canad. Ent. 98:859-866.
- Busck, A. 1933. In: Minutes of the 449th regular meeting of the Entomological Society of Washington, Oct. 5, 1933. Proc. Ent. Soc. Wash. 35:191-192.
- DeBach, P. 1965. Some biological and ecological phenomena associated with colonizing entomophagous insects, pp. 287-303. In: H. G. Baker and G. L. Stebbins, eds., The genetics of colonizing species. Academic Press, New York and London.
- Frick, K. E., and R. B. Hawkes. 1970. Additional insects that feed upon tansy ragwort, *Senecio jacobaea*, an introduced, weedy plant, in the western United States. Ann. Ent. Soc. Amer. 63:1085-1090.
- Goeden, R. D., and D. W. Ricker. 1976a. The phytophagous insect fauna of the ragweed *Ambrosia dumosa* in southern California. Environ. Ent. 5:45-50.
- . 1976b. The phytophagous insect fauna of the ragweed *Ambrosia psilostachya* in southern California, U.S.A. Environ. Ent. 5:1169-1177.
- Langston, R. L., and J. A. Powell. 1975. The earwigs of California (Order Dermaptera). Bull. Calif. Insect Survey 20:1-25.
- Lynn, C. D. 1969. Omnivorous leaf roller, an important new grape pest in the San Joaquin Valley. Calif. Agric. 23(4):16-17.
- Mann, B. P. 1885. Herbert Knowles Morrison. Psyche 4:287.
- Powell, J. A. 1964. Biological and taxonomic studies on tortricine moths, with reference to the species in California (Lepidoptera: Tortricidae). Univ. Calif. Publ. Ent. 32:1-317.
- . 1980. Evolution of larval food preferences in microlepidoptera. Ann. Rev. Ent. 25:133-159.
- . 1981. Five insects believed to be newly established or recolonized on Santa Cruz Island, California (Dermaptera, Lepidoptera). Bull. So. Calif. Acad. Sci. 79:97-108.
- Powell, J. A., and J. M. Burns. 1971. Colonization of the northeastern United States by two Palearctic moths (Lepidoptera: Tortricidae). Psyche 78:38-48.
- [Smith, J. B., ed.] 1885. Obituary note. Ent. Amer. 1:100.
- Walsingham, Lord T. 1884. North American Tortricidae. Trans. Ent. Soc. London 1884:121-147.
- Woglum, R. S. 1920. A recently discovered citrus pest, *Platynota tinctana* (Walk.) in California. Calif. Dept. Agric. Mo. Bull. 9:341-343 [based on *P. stultana* misidentified by A. Busck].

**Identification and Synonymies of Two Western Palearctic
Cerceris: maculata Radoszkowski and *hathor* n. sp.
(Hymenoptera: Sphecidae)**

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The identities of *Cerceris orientalis* Mocsáry and *haematina* Kohl have been a problem for hymenopterists because their original descriptions were inadequate and the types could not be found. This paper presents the results of my study of these problems and is dedicated to the anniversary of Dr. R. M. Bohart. I sincerely thank Arnold S. Menke for discussing various aspects of the study, and Mary Ann Tenorio for drawing the figures.

***Cerceris maculata* Radoszkowski**

Cerceris maculata Radoszkowski, 1877:57, ♀. Holotype ♀: Uzbek SSR: Kyzil Kum Desert (Zool. Mus. Moscow Univ.).—Shestakov, 1918:141.

Cerceris orientalis Mocsáry, 1883:47, ♀. Holotype ♀: "Russia mer.-orient." = Kazakh SSR, not Caucasus (lost, see below). **Neotype**: holotype of *Cerceris maculata* Radoszkowski, present designation. Nec F. Smith, 1856. **New synonym.**

Cerceris eugenia Schletterer, 1887:390, new name for *Cerceris orientalis* Mocsáry, 1883.—Shestakov, 1918:131; Kazenas, 1978:58.

Cerceris Moscaryi Kohl, 1888:139 (incorrect original spelling), new name for *Cerceris orientalis* Mocsáry, 1883.—Schletterer, 1889:890; ? Shestakov, 1918:146 (as *mokzaryi*).

Cerceris haematina Kohl, 1916:111, ♀. Holotype ♀: origin unknown (lost, see below). **Neotype**: holotype of *Cerceris maculata* Radoszkowski, present designation. **New synonym.**

Diagnosis.—The female of *maculata* can be distinguished from other members of the *bupresticida* species group by the roundly triangular lamella of sternum V. The male can be recognized by the absence of micropunctuation on the frons adjacent to the frontoclypeal suture between the subantennal sclerite and tentorial pit. See the description of *hathor* for further details.

Nomenclature.—The correct interpretation of *eugenia* and *haematina* is particularly difficult because the original descriptions are inadequate, and the type material is apparently lost. As Dr. M. Fischer kindly informed me in his letter of 16 November 1981, no specimen named *eugenia*, *haematina*, or *orientalis* can be found in the Naturhistorisches Museum, Vienna, a situation already partly reported by de Beaumont (1951b:340). A specimen thought to be the holotype of *orientalis* Mocsáry, housed at the Hungarian National Museum, Budapest, was kindly submitted to me by Dr. J. Papp. It bears a handwritten label "*Cerceris mocsaryi* Kohl, *orientalis* Mocsary" in Mocsáry's handwriting, but no locality label. It is a female of *fischeri* (see below) and is apparently the specimen studied

Table 1. Comparison of presumed holotype of *orientalis* Mocsáry (Hungarian National Museum, Budapest) with original description (1883).

Body part	Specimen from Budapest	Mocsáry, 1883 description
1. Scape	all yellow	black basodorsally
2. Clypeal apex	brownish, truncate	black, crenulate
3. Tergum II	yellow basally	yellow laterally
4. Tergum IV	black	yellow posteriorly and laterally
5. Tibiae	all yellow	yellow, darkened mesoventrally

by Schletterer (1887, 1889) and by Kohl in 1888 (Kohl, 1888:139, 1916:111) and regarded by them as Mocsáry’s holotype. Actually, it cannot be the true holotype of *orientalis*, because it differs significantly from the original description, as shown in Table 1.

The discrepancy in the color of terga II and IV is particularly striking and I doubt that Mocsáry would have made such an error. Schletterer redescribed *orientalis* twice: in 1887 under the replacement name *eugenia* Schletterer, and in 1889 under the replacement name *mocsaryi* Kohl. As Kohl (1888) pointed out, Schletterer’s 1887 redescription was based on a specimen not conspecific with the holotype. The same must now be said about his 1889 redescription: it clearly indicates a specimen different from the material Mocsáry (1883) had before him, and it well agrees with the specimen labelled *orientalis* received for study from the Hungarian National Museum. This suggests that the holotype of *orientalis* was confused by Schletterer with two other specimens, so that a total of three must have been involved: 1. the holotype of *orientalis* (its possible fate is discussed below), 2. an Egyptian female of *hathor* on which Schletterer (1887) based his description of *eugenia* (now lost, see also under *hathor* below), and 3. a female of *fischeri* which Kohl (1888) and Schletterer (1889) regarded as the holotype of *orientalis*, on which they based their redescriptions of *mocsaryi*, which was then returned to Budapest as the holotype of *orientalis*, and which finally was submitted to me.

It is also very probable that the holotype of *haematina* Kohl was the misplaced holotype of *orientalis* Mocsáry. Descriptions of these two species show an almost identical set of characters, including the characteristic lateral spots on tergum II. The original locality or area of *haematina* is unknown, and the holotype of *orientalis* had no origin label, a coincidence which also suggests that the same specimen may have been involved. Most probably, the true holotype of *orientalis* was kept unrecognized in the Vienna Museum while the supposed false holotype was returned to Budapest after publication of Schletterer’s monograph (1887, 1889). When casually discovered by Kohl (1916) many years later, it was then described by him as *haematina*.

According to the original description, the holotype of *orientalis* originated from “Russia meridionalis vel Caucasus.” However, this origin is corrected to “Russia mer.-orient.” in Mocsáry’s characteristic handwriting in a reprint of the original paper (a xerox copy kindly sent by Dr. J. Papp). “Russia mer.-orient.” of Mocsáry is almost certainly today’s Kazakh SSR.

Several characters given in Mocsáry’s original description help in recognition

of *orientalis*: clypeus convex (without discal process), with crenulate free margin; propodeal enclosure unsculptured; propodeum and gastral tergum I reddish; tergum II with lateral spots; terga III–V fasciate (fasciae broadened laterally). These characters suggest that *orientalis* is identical to *maculata*. I have seen the holotype and four additional females of *maculata* (three of them kindly sent by Dr. V. L. Kazenas, Alma Ata). None is identical in coloration to the holotype of *orientalis*, but the observed variation of the latter strongly suggests that they are conspecific with it. For example, the propodeum in the specimens studied is all black, or with small red spots, or largely red. Gastral tergum II has an oblong, yellow, lateral spot or the yellow covers the whole tergum except a semilunar apicomedian area (as in the holotype of *maculata*). There is little doubt that many specimens of *maculata* have exactly the same coloration as Mocsáry's holotype. Because of the observed variation, I designate the holotype of *maculata* as the neotype of both *orientalis* and *haematina*, even if the yellow area of tergum II is larger in the first than indicated in the descriptions of the latter two. This decision will end a complex nomenclatorial problem.

Cerceris fischeri Spinola

Cerceris fischeri Spinola, 1839:493, ♀, ♂. Syntypes: Egypt (Inst. Zool. Univ. Turin), see de Beaumont, 1951a:175.

Cerceris mocsaryi: Kohl, 1888:139; Schletterer, 1889:890.

The specimen which Kohl (1888) and Schletterer (1889) erroneously regarded as the holotype of *orientalis* Mocsáry and which they redescribed under the name *mocsaryi* Kohl (see above) is a female of *fischeri*, a member of the *rybyensis* species group of de Beaumont (1951b). The female of *fischeri* can be recognized by the following combination of characters: propodeum around enclosure impunctate or with a few scattered, punctures; and sternum V prominent posterolaterally. The male can be recognized by the presence of a well defined, basal platform on sternum II combined with acutely angulate posterolaterally sternum VI. Subsidiary recognition features of both sexes are: hypoepimeral area carinate below, propodeal enclosure unsculptured.

Cerceris hathor Pulawski, NEW SPECIES

Cerceris eugenia: Schletterer, 1887:390; Kohl, 1888:139, 1916:111; de Beaumont, 1951a:180, 1951b:339, 1953:122, 1956:186, 1958:59; de Beaumont and Bytinski-Salz, 1959:122; Pulawski, 1964:73.

Cerceris tricolorata: Mochi, 1938:190; Giner Marí, 1941:174.

Cerceris vidua: Honoré, 1941:150, 1942:69.

Etymology.—Hathor, a goddess of ancient Egyptians, in apposition.

Nomenclature.—As Kohl (1888) pointed out, Schletterer (1887) examined the holotype of *Cerceris orientalis* Mocsáry and renamed the species *eugenia*, but his description was based on a specimen belonging to a different species. Kohl (1888) and also de Beaumont (1951b) applied the name *eugenia* to this latter species, but Article 72(d) of the Code is clear: the replaced name (*orientalis*) and the replacement name (*eugenia*) must have the same holotype. This means that the species described by Schletterer under the name *eugenia* must bear a different name.

Schletterer (1877) mentioned two geographic areas in which *eugenia* supposedly occurs: southeastern Russia (= present Kazakh SSR) and Egypt. Since the holotype of *eugenia* originated from the first area, his description must have been based on an Egyptian specimen. Even though the latter was subsequently lost, de Beaumont (1951b) was able to recognize and to characterize (as *eugenia*) the species to which it belonged. The species has no available name and is here described as *hathor*.

Systematics.—*Cerceris hathor* is a member of the *bupresticida* species group of de Beaumont (1951b). The group, redefined by Krombein (1981), includes the following species:

bidentula Maidl, 1926; southern India, Sri Lanka, Thailand, Malaya, Celebes
(= *langkasukae* Pagden, 1934)

ssp. *bidentula spiniventris* Tsuneki, 1963; Thailand

bupresticida Dufour, 1841; Mediterranean basin, Transcaspia, Afghanistan

hathor Pulawski, n. sp.; North Africa, Israel, Azerbaidzhan

kokuevi Shestakov, 1912; Transcaspia

(= *egregia* Kazenas, 1977, according to V. L. Kazenas's identification labels)

maculata Radoszkowski, 1877; Transcaspia

(= *eugenia* Schletterer, 1887, *haematina* Kohl, 1916)

mastogaster Smith, 1856; India, Sri Lanka

odontophora Schletterer, 1887; Balkans, Turkey, Iran, Transcaspia

palmetorum de Beaumont, 1951; North Africa

supposita Kohl, 1916, as interpreted by Kazenas, 1978 (perhaps not conspecific with the holotype of *supposita*); Transcaspia

tricolorata Spinola, 1839; North Africa

This list may be incomplete, and other described species, especially Oriental and Ethiopian, may belong here. Some of the species listed above are insufficiently known, and some were unavailable for comparison during this study. My interpretation of *supposita* and *kokuevi* is based on specimens so labelled and kindly sent to me by Dr. V. L. Kazenas.

Diagnosis.—The female of *hathor* can be recognized by the combination of: propodeum sparsely punctate, sternum V nondentate posterolaterally, and lamella of sternum V evenly arcuate. The shape of gastral segment VI is the same in males of *hathor*, *maculata* and *odontophora*: its sternum is dentate posterolaterally, and its tergum is not. Unlike *maculata*, the face in males of *hathor* is densely micro-punctate including the area above the frontoclypeal suture, and unlike *odontophora*, the propodeum is sparsely punctate outside the enclosure.

Comparative description.—At least some punctures of the propodeal dorsum around enclosure are about 1 diameter apart (punctures compressed against each other in *bidentula spiniventris*, *bupresticida*, and *odontophora*, and in some males of *maculata*). Hindcoxa with medioventral carina (carina absent in *kokuevi* and *palmetorum*). Gastral sternum II with indistinctly delimited basal platform (similar platform present in *kokuevi*, *maculata*, *mastogaster*, *supposita*, and female of *bidentula spiniventris*; platform absent in *bupresticida*, *odontophora*, *tricolorata*, and male of *bidentula spiniventris*). Thorax black or partly red, but tegula and in most populations also pronotum and metanotum pale yellow (metanotum black

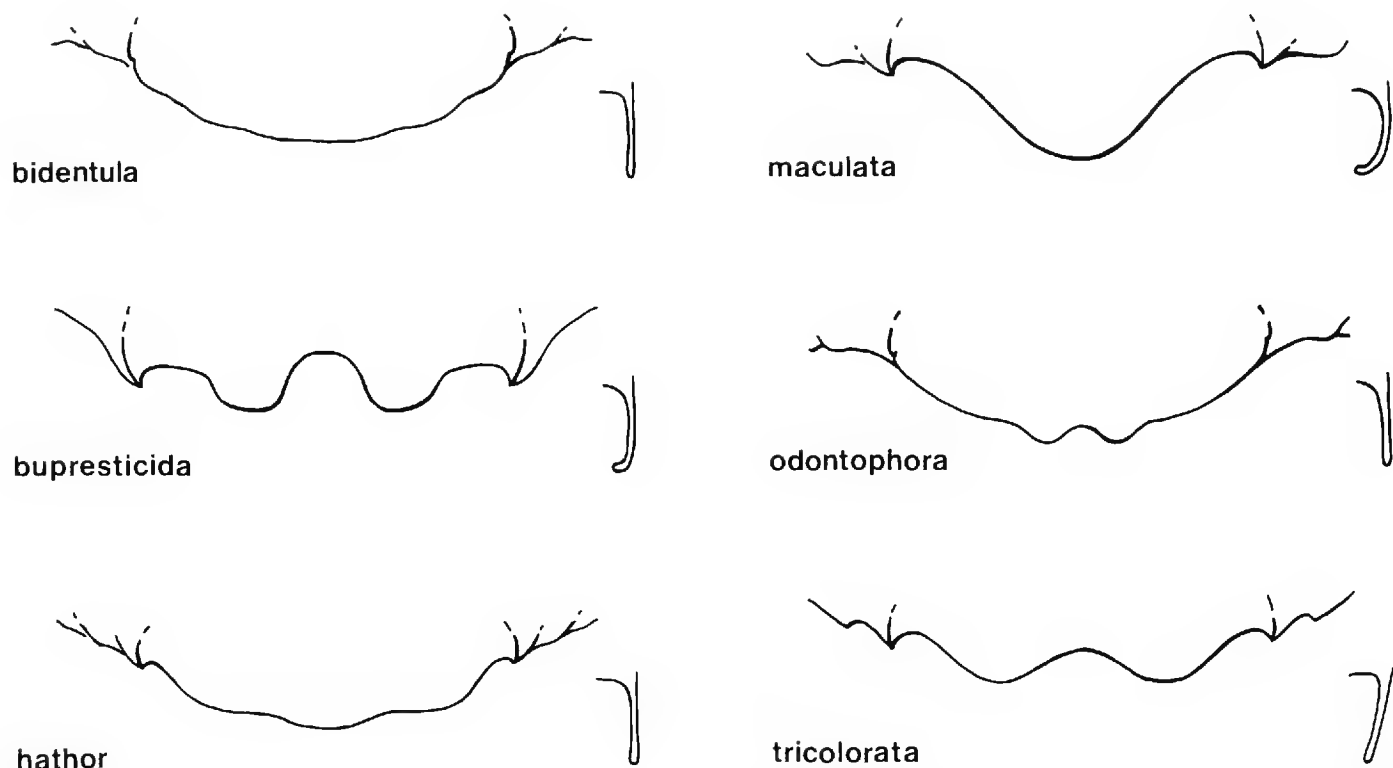


Fig. 1. Species of *Cercheris*. Ventral view of female sternum V showing apical outline. Small drawing to right of each illustration shows cross-section profile of sternal apex.

in *odontophora*, mesoscutum and propodeum partly to all yellow in *kokuevi* and *palmetorum*).

Female.—Clypeal middle section with two admedian tubercles near free margin (tubercles absent in *tricolorata*). Sterna III–V without sublateral process (process present in *mastogaster*: Krombein, 1981). Gastral sternum V (Fig. 1) tuberculate posterolaterally (similarly in *odontophora* and *tricolorata*, angulate in *maculata* and *supposita*, dentate in *bidentula spiniventris*). Apicomedian lamella of sternum V evenly rounded, its midlength less than its width (lamella almost identical in *bidentula spiniventris*; with semicircular notch in *bupresticida*; roundly triangular in *maculata*; strong, erect, triangular in *mastogaster*: Krombein, 1981; semicircular, shallowly notched apically in *odontophora*; trapezoidal, with width about twice length in *supposita*; with widely concave free margin in *tricolorata*). Lateral carina of tergum VI not expanded (expanded at midlength in *supposita*).

Male.—Face with large punctures and numerous micropunctures between tentorial pit, antennal socket and orbit (micropunctures indistinct in *bidentula spiniventris*, absent adjacent to frontoclypeal suture in *maculata* and *supposita*). Gastral terga I and II not elongate: spiracles of tergum I closer to tergal hindmargin than to each other (terga I and II elongate in *bidentula spiniventris* and *tricolorata*: spiracles of tergum I about equidistant from each other and tergal hindmargin). A spine-like, posterolateral projection present on sternum VI, but absent from tergum VI (similar in *maculata* and *odontophora*; projection absent on tergum and sternum in *kokuevi* and *palmetorum*; and present on tergum and sternum in *bidentula spiniventris*, *bupresticida*, *mastogaster*, and *tricolorata*).

Geographic distribution.—Desert habitats of North Africa and Israel, probably also Azerbaidzhan SSR.

Material examined.—Holotype ♀: EGYPT, Ghiza near Cairo, 20 Apr. 1958, W. J. Pulawski collector (W. J. Pulawski collection). Paratypes: EGYPT, Kom

Oshim on Ghiza-Fayum road, 19 April to 13 May 1958, same collector and depository (1 ♀, 4 ♂).

Literature records.—MOROCCO: Midelt (de Beaumont, 1951b, 1953). ALGERIA (de Beaumont, 1951, 1958): Biskra, Laghouat, Tadjemout, Tassili des Ajjer (Oued Ténéouène, Oued Ti'Harat). CHAD: Tibesti: Zouarke (de Beaumont, 1956). EGYPT: Ghiza near Cairo, Kom Oshim on Cairo-Fayum road (Pulawski, 1964), Gebel Asfar near Cairo (Honoré, 1941). ISRAEL (Negev Desert): Beer-sheba, Gvulot, Kfar Yeroham, Revivim (de Beaumont and Bytinski-Salz, 1959). AZERBAIDZHAN SSR: Adzhikend (Kohl, 1916).

LITERATURE CITED

- de Beaumont, J. 1951a. Synonymie de quelques *Cerceris*. 2. (Hym., Sphecidae). Mitt. Schweiz. Ent. Ges. 24:175-180.
- . 1951b. Contribution à l'étude des *Cerceris* nord-africains. EOS Rev. Española Ent. 27:299-408.
- . 1953 (1952). Hyménoptères récoltés par une mission suisse au Maroc (1947). Sphecidae 2. Bull. Soc. Sci. Nat. Phys. Maroc 32:107-131.
- . 1956. Sphecidae (Hym.) récoltés en Libye et au Tibesti par M. Kenneth M. Guichard. Bull. Brit. Mus. (Nat. Hist.) Ent. 4:165-215.
- . 1958. Hyménoptères Sphecides de la mission du Tassili des Ajjer (1949). Trav. Inst. Rech. Sahar. 3:55-71.
- de Beaumont, J., and H. Bytinski-Salz. 1959. The Sphecidae (Hymen.) of Eretz Israel. II. Subfam.: Nyssoninae (tribes: Gorytini, Nyssonini, Alyssonini) and Philanthinae. Bull. Res. Counc. Israel B8:99-151.
- Giner Marí, J. 1941. Los *Cerceris* de Africa paleártica. EOS Rev. Española Ent. 17:135-291.
- Honoré, A. 1941. Notes sur quelques *Cerceris* de la faune égyptienne (Hymenoptera: Sphegidae). Bull. Soc. Fouad I^{er} Ent. 25:145-162.
- . 1942. Introduction à l'étude des Sphegides en Egypte (Hymenoptera: Aculeata). Bull. Soc. Fouad I^{er} Ent. 26:25-56.
- Kazenas, V. L. 1978. Royushchiye osy Kazakhstana i Sredney Azii (Hymenoptera, Sphecidae). Oprelidelitel. Izdatelstvo Nauka Kazakhskoy SSR, Alma Ata, 172 pp.
- Kohl, F. F. 1888. Neue Hymenopteren in den Sammlungen des k. k. naturhistorischen Hofmuseums. Verh. Zool. Bot. Ges. Wien 38:133-156.
- . 1916 (1915). Beitrag zur Kenntnis der Gattung *Cerceris* auf Grundlage der O. Radoszkowskyschen Sammlung. Arch. Naturgesch., Abt. A, 88 (7):107-125.
- Krombein, K. V. 1981. Biosystematic studies of Ceylonese wasps, VIII, A monograph of Philanthidae (Hymenoptera: Sphecoidea). Smithsonian Contrib. Zool. No. 343:i-iii, 1-75.
- Mochi, A. 1938. Revisione delle specie egiziane del genere *Cerceris* Latr. (Hymenoptera: Sphegidae-Philanthinae). Bull. Soc. Fouad I^{er} Ent. 22:136-229.
- Mocsáry, A. 1883. Hymenoptera nova Europaea et exotica. Érték Természettud. Köréből 13(11): 1-72.
- Pulawski, W. J. 1974. Etudes sur les Sphecidae (Hym.) d'Egypte. Polskie Pismo Ent. 34:63-155.
- Radoszkowski, O. 1877. Sphegidae. In: Voyage au Turkestan d'A. P. Fedchenko, fasc. 14, tome 2, partie 5. Bull. Soc. Impér. Amis. Sci. Nat. 26:1-87.
- Schletterer, A. 1887. Die Hymenopteren-Gattung *Cerceris* Latr. mit vorzugsweiser Berücksichtigung der paläarktischer Arten. Zool. Jahr., Abt. Syst. 2:349-510.
- . 1889. Nachträgliches über die Hymenopteren-Gattung *Cerceris* Latr. Zool. Jahr., Abt. Syst. 4:879-904.
- Shestakov, A. V. 1918 (1917). Matériaux pour servir à une faune des guêpes du genre *Cerceris* Latr. (Hymenoptera, Crabronidae). Ann. Mus. Zool. Acad. Sci. Russie 22:118-166.
- Spinola, M. 1839 (1838). Compte-rendu des Hyménoptères recueillis par M. Fischer pendant son voyage en Egypte, et communiqués par M. le Docteur Walzl à Maximilien Spinola. Ann. Soc. Ent. France 7:437-546.

A Fluorescing Insect, *Cysteodemus armatus* LeConte (Coleoptera: Meloidae)

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This paper is not about Sphecidae, Vespidae or Chrysididae. It is not even about Hymenoptera, but concerns a very unusual, perhaps unique beetle. Because the uniqueness of the beetle reflects many of the same qualities possessed by Dick Bohart, apparent to both his students and peers, we honor him on his seventieth birthday by dedicating this paper to him.

In the animal world, very few species possess structures or structural modifications that fluoresce. Some deep sea fishes (Bond, 1979) and marine chaetopterians (Maglitsch, 1972) and cephalopods (Barns, 1980) fluoresce, many with the aid of fluorescing bacteria. Of the terrestrial animals, scorpions (Williams, 1968; Williams and Hadley, 1967) and some agelenid spiders (T. Lugaski, pers. comm.) fluoresce. Here we report on the fluorescence observed for the first time in an insect, the meloid beetle, *Cysteodemus armatus* LeConte.

While collecting scorpions with ultraviolet (UV) lamps near Lava Dune, 10 km WNW Lathrop Wells, Nye County, Nevada (116°30'W-36°41'N) on May 15, 1982, a roundish yellow-green fluorescing "rock" was found. The "rock" got up and walked away from the radius of the UV light. It proved to be a living specimen of *Cysteodemus armatus* (Meloidae: Meloinae: Eupomphini). The specimen was placed in a glass specimen vial and returned to camp for further observation. Continued collecting with UV lamps that evening produced no more specimens of *C. armatus*. The fluorescence had been observed with light from a 120 volt 6 watt black light tube (F6T5/BLB). In white light or sun light the beetle had a light yellow dusting on the dorsal surface of the exoskeleton which was responsible for the fluorescence observed with the UV light (Fig. 1). The material, a cuticular secretion most likely wax or lac epicuticle, was easily picked off with a dissecting needle or fine scalpel. The material was not soluble in ethanol, chloroform or water and retained its fluorescing property in those liquids. Eleven additional specimens of *C. armatus* in the collection of the Nevada State Department of Agriculture also fluoresced under UV light. These specimens were from several different locations in Nevada. Fourteen genera of meloid beetles were checked for UV fluorescence, but none fluoresced. One or more species in the following genera were checked: *Meloe*, *Cordylospasta*, *Eupompha*, *Spastonyx*, *Phodaga*, *Pleurospasta*, *Tegrodera*, *Pyrota*, *Lytta*, *Epicauta*, *Linsleya*, *Nemognatha*, *Tricrania* and *Pseudozonitis*.

Other Coleoptera with "dusty" exoskeletons were examined under UV light for fluorescence, but none fluoresced. Species examined included: (Elateridae) *Alaus melanops* LeConte, *A. myops* (Fabricius), *A. oculatus* (L.) and *Chalcolepidius asperata discreta* Blaisdell, *C. variolosa* Horn, *Phloeodes diabolicus* LeConte, *P.*



Fig. 1. *Cysteodemus armatus* LeConte photographed with UV light and Kodak® Plus X film with 30 second exposure. The waxy epicuticle has been removed from the right elytron to show the contrasting pattern of fluorescence.

pustulosus LeConte, *Zopherus elegans* Horn, *Z. laevicollis* Solier, *Z. nodulosus haldemani* Horn and *Z. nodulosus nodulosus* Solier.

Two questions arise from this observation: how and why fluoresce? The “how” question will be answered by biochemists when the fluorescing compound is known. Many organic molecules are known to fluoresce (anthracene, perylene, pyrene, quinine) and the fluorescence produced is from radiative transitions between states of like multiplicity and visible most often in UV light (Cowan and Drisko, 1976). The “why” question is more difficult to answer. However, a simple explanation may be that certain organic compounds fluoresce and one of these compounds is found in the waxy layers of the *C. armatus* exoskeleton. Thus, the fluorescence would have nothing to do with evolution or selection in the past history of the beetle. On the other hand, the compound that fluoresces could be involved with antipredator behavior, waterproofing, light or heat reflectance, storage of a waste product, or be more basic in mate selection or location. We do not have enough information to know.

We thank Drs. Gary Bloomquist and Glenn Miller for their thoughts and comments on the chemistry of fluorescing compounds.

LITERATURE CITED

- Barns, R. D. 1980. Invertebrate zoology. Saunders Publ., Philadelphia.
- Bond, C. E. 1979. Biology of fishes. Saunders Publ., Philadelphia.
- Cowan, D. O., and R. L. Deisko. 1976. Elements of organic photochemistry. Plenum Press, New York.
- Meglitsch, P. A. 1972. Invertebrate zoology. Oxford University Press, New York.
- Williams, S. C. 1968. Methods of sampling scorpion populations. Proc. Calif. Acad. Sci. (4)36:221-230.
- Williams, S. C., and N. F. Hadley. 1967. Scorpions of the Puerto Penasco area (Cholla Bay), Sonora, Mexico, with description of *Vejovis baergi*, new species. Proc. Calif. Acad. Sci. (4)35:103-116.

A New Spider Parasitoid, *Ocnaea boharti*, from Arizona and New Mexico (Diptera: Acroceridae)

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The genus *Ocnaea* Erichson (1840) has 19 included species, ranging from California and Georgia, south to Brazil and Ecuador. Nine species occur in the United States, five in Central America and the Caribbean, and three in Brazil and Ecuador. In addition to the new species described here, I have on hand four additional species from Brazil, Venezuela and Costa Rica. Species from Chile described earlier in *Ocnaea* were discussed by Schlinger (1968) and were referred to *Ar-rhynchus* Philippi. All species described in *Pialeoidea* Westwood were placed in *Ocnaea* by Schlinger (1961), and other *Ocnaea* species have been removed and placed in *Exetasis* Walker (see Schlinger, 1968 and 1972).

Biological notes on species of *Ocnaea* are rare, and the only recorded host is the California trapdoor spider, *Bothriocyrtum californicum*, from which Jenks (1940) reared *Ocnaea smithi* Sabrosky (1948). Known host records and immature stages of *Ocnaea* and related panopine genera were published by Schlinger (1972).

Ocnaea species are rather large flies (5-20 mm), yet published records on known specimens, including the type specimens, have numbered less than 25 since the genus was described 142 years ago. During the past 30 years that I have been identifying acrocerids from collections from around the world, I have examined only an additional 15 specimens. These data attest to the peculiar rare status of these "large" flies in that only 40 specimens are known to have been collected or reared in the past 150 years.

A further complication to the study of this genus is the high degree of sexual dimorphism known in the few species where both sexes have been associated. Other than the new species described below, only *O. smithi* has both sexes described. This indicates that some new synonymy may be expected as further specimens become available.

I wish to thank Dr. Mont Cazier, Arizona State University at Tempe, for the loan of the holotype specimen and Dr. James Sublette, New Mexico State University at Las Cruces for the loan of the paratype specimen. These type specimens will be deposited in the California Academy of Sciences, San Francisco, California.

Special acknowledgment is given to Mrs. Celeste Green, my friend and former Scientific Illustrator in the Department of Entomology, University of California at Berkeley, for her excellent color rendering of this new species.

Ocnaea boharti Schlinger, NEW SPECIES (Plate I, Figs. 1, 2)

Male.—Length of entire specimen 10.00 mm, wing length 7.00 mm.

Color.—Yellow, white, brown, and black, with faint metallic bluish-brown reflexions on mesonotum, scutellum and on medial tergal spots; black are eyes and

occiput; dark brown are outer and dorsal margins of antennal segment III, antennal segments I–II, posterior $\frac{1}{2}$ of antennal tubercle, mesonotum, scutellum, coxae, most of pleura, sternal area (almost black), most of tergite I, large medial spot on tergites II and V, smaller medial spot on tergites III–IV, and tarsal claws; yellow are remainder of tergal areas, most of sternites I–IV, most of legs, squamal rim and wing veins; light brown are inner and ventral margins of antennal segment III, anterior $\frac{1}{2}$ of antennal tubercle, area around and beneath wing base, post-alar callus, inner sides of femora I and II, tiny spot at knees, tibial spurs, tip of basitarsi, pulvilli, halter stem and knob, small lateral spot on sternite IV and most of sternite V; dull white are humerus, squama (nearly opaque), wing membrane (hyaline), narrow posterior fascia on tergites I and II and sternite IV, and somewhat wider fascia on sternites II and III; genitalia are yellowish-brown, and ocelli are orange-brown.

Pile.—Light brown and dense on eyes and occiput, reaching out to base of antennal segment II; longer below near mouth and above near ocelli; that on thorax dense, white, long, nearly obscuring ground color, somewhat longer than the longest pile on eyes; that on abdomen mostly white, long and dense on tergite II dorsally and tergites V and VI laterally; that on medial tergal spots light brown and shorter; remainder white, shorter, and less dense than on mesonotum.

Head.— $\frac{1}{3}$ higher than long (Pl. I), antenna $\frac{1}{3}$ longer than head height; antenna asetate except for small group of dorsal setae on segment II; proboscis not evident, but a group of stout hairs project from underneath tiny “proboscial” covering.

Thorax.—With shining ground color, difficult to detect under dense pile; humerus strongly developed and directed anteriorly, reaching in front of eyes, becoming nearly acuminate (Pl. 1); humerus length subequal to that of head height; femur III hardly longer than I and II; tibia III swollen and about as long as femur III; (Pl. I), venation with cell R_5 open at wing margin and membrane without macrotrichiae.

Abdomen.—Shiny, rather narrow, not much wider than thorax; tergites II–IV subequal in width; genital capsule large, aedeagus formed as in Fig. 1.

Female.—Length of entire specimen 10.00 mm, wing length 10.00 mm. Similar to that described for male above except for obvious differences as follows:

Color.—Black also are antennal segment III (except extreme base dark brown), most of coxae and tergite I; dark brown with bluish-brown to black reflections on large dorso-medial spot, and extreme lateral margins of tergites II and III, all of tergites IV–VI, and most of sternites I–VI (except for narrow whitish-light brown fascia on sternites III and IV); dark brown are squamal rim, halter knob, femora, inner side of tibia and tarsi (most legs are broken at end of tibia or absent altogether); whitish-brown are outer basal $\frac{1}{3}$ of tibiae and humerus; light brown are wing veins.

Pile.—Not dense throughout, more dark brown on eyes, that on mesonotum lightly mixed with light brown; that on mesonotum lightly mixed with light brown; that on abdomen more brown than white.

Head.—Much smaller than male (Fig. 2), more round, about as high as long; antenna $1\frac{1}{2}$ times longer than head height; antennal segment III with small but distinct group of dorsal, subapical setae.

Thorax.—Shiny, ground color not obscured by pile; humerus $\frac{1}{3}$ longer than head height, slightly more curved and more acuminate than in male (Fig. 2); tibia

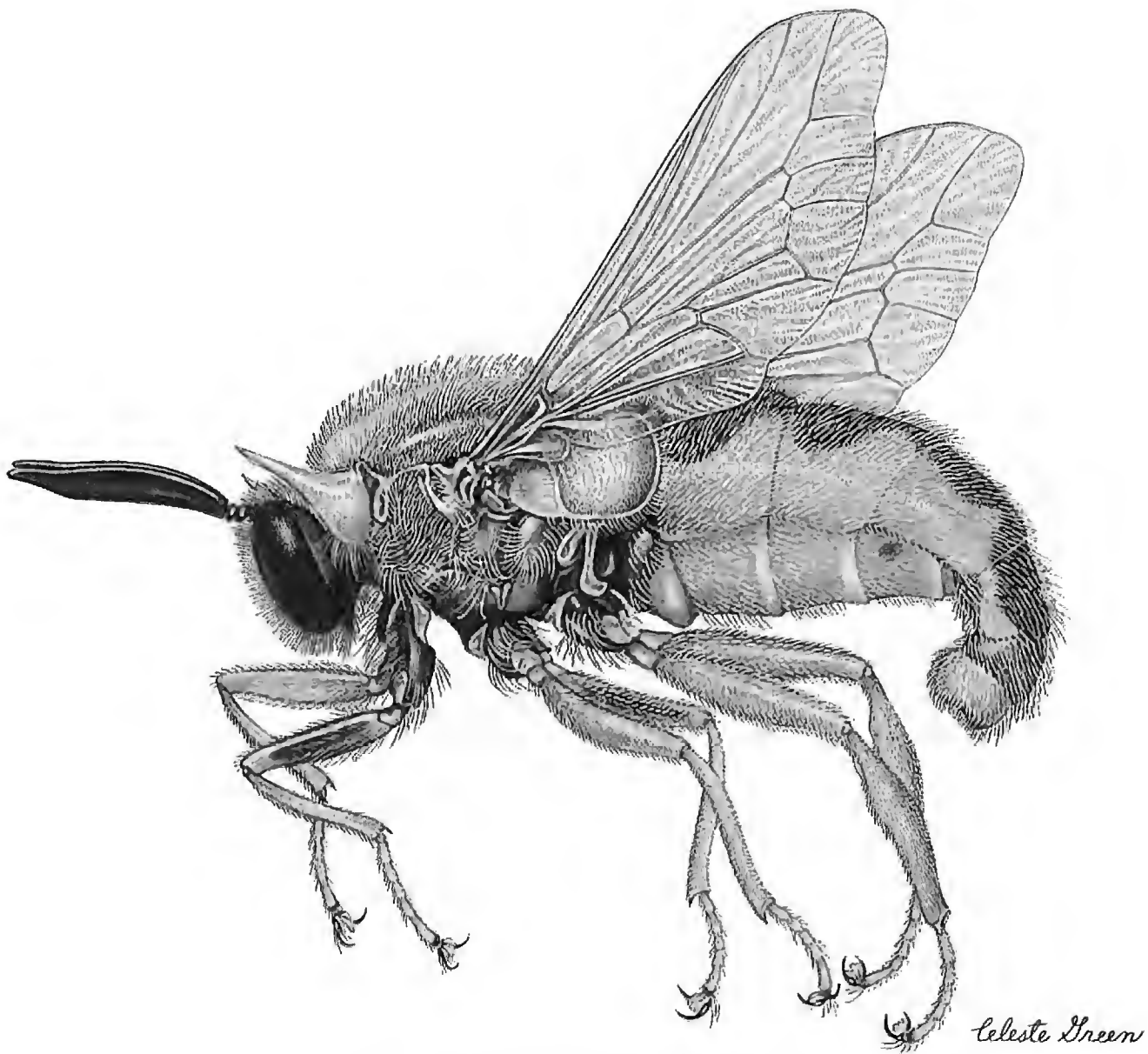


Plate I. *Ocnaea boharti*, holotype male.

III not swollen, but tibia II shortened and sinuated; squamal membrane nearly clear; wing membrane lightly infuscated throughout; sparse but distinct macrotrichiae present in membrane throughout length of costal cell; venation similar to male but some cells (especially R_5) are longer and therefore somewhat differently shaped.

Abdomen.—Little wider than thorax, widest at tergite III (broken off and re-glued).

Types.—Holotype ♂, ARIZONA: 2 mi. NE Portal, November 3, 1960 (M. A. Cazier), from the Arizona State University at Tempe Collection. Paratype ♀, NEW MEXICO: *Roosevelt Co.*, October 31, 1964 (A. Berg) from the New Mexico University Collection in Las Cruces.

I should note that while I have little doubt that the paratype is the female of this species, certain secondary sexual characters which are evident in this specimen are known to occur in both sexes of certain other species of *Ocnaea*. One such character is the presence of a distinct, but sparse series of macrotrichiae in the costal cell. Another is the darker brown wing veins and lightly infuscated wing membrane. Finally, the small, more-rounded head of this female is obviously different (compare Pl. I with Fig. 2), and while this trait occurs in some species of certain related genera, i.e. *Pialea* Erichson, it is not known in *Ocnaea* species.

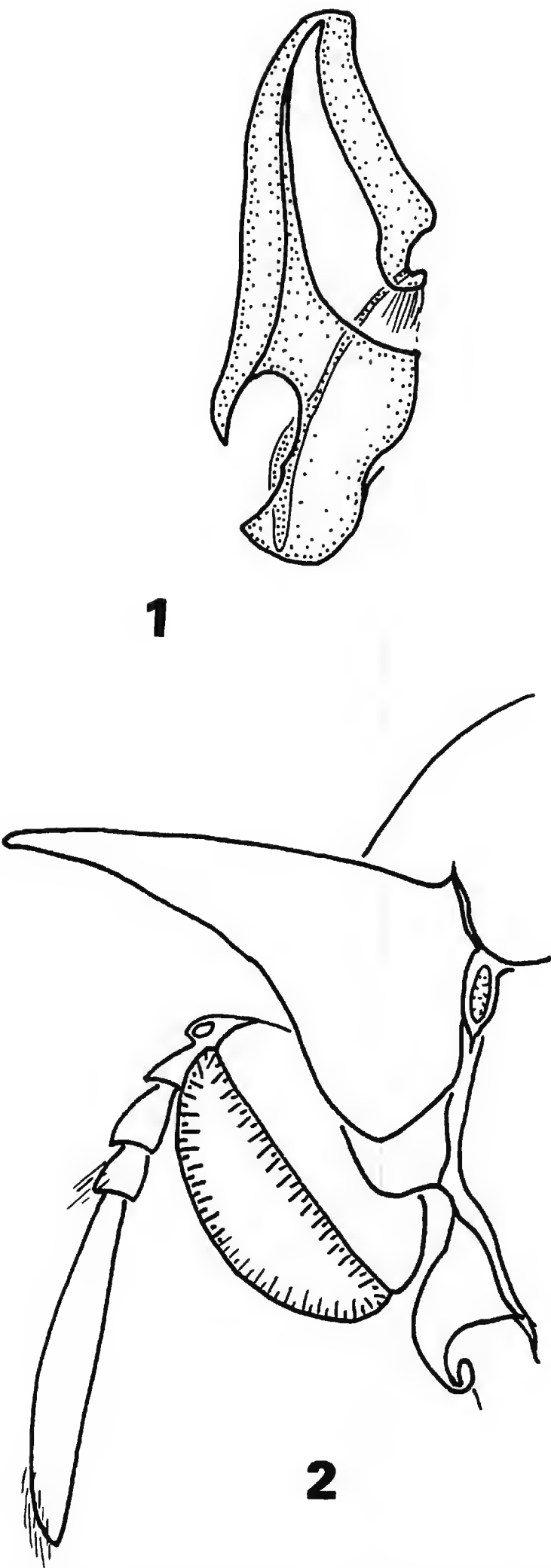


Fig. 1. *Ocnaea boharti*, aedeagus in lateral view, holotype.

Fig. 2. *Ocnaea boharti*, head and humerus in lateral view, paratype female.

This new species, with its stiletto-like humeri, shows no close relationship to any known *Ocnaea*, and seems to form its own unique species group. Its color combination of yellow, brown and shiny bluish-brown reflections are very reminiscent of the Chilean species, *Arrhynchus vittatus* Philippi. The relationship of *Arrhynchus* to *Ocnaea* was discussed in detail by Schlinger (1968), and while these genera are closely related, no species within either genus has this distinctly modified humerus (in either sex) while *O. boharti* n. sp., has this character in both sexes.

It is with the greatest pleasure that I name this new species for my colleague and former major professor, Dr. Richard M. Bohart, for whom I have the greatest respect both as a person and as a professional entomologist.

LITERATURE CITED

- Erichson, W. F. 1840. Die Henopier, eine Familie aus der Ordnung der Dipteren, pp. 135-175, pl. I, figs. 7-10. Entomographien, Untersuchungen in dem Gebiete der Entomologie mit besonderer Benutzung der Konigl. Sammlung zu Berlin, vol. 1, Berlin.
- Jenks, G. E. 1940. The spider's "uninvited" fly brings doom. Natural History (Magazine) 45:157-161.
- Sabrosky, C. W. 1948. A further contribution to the classification of the North American spider parasites of the family Acroceratidae (Diptera). Amer. Mid. Nat. 39:382-430.
- Schlinger, E. I. 1961. New species of *Acrocera* from Arizona and *Ocnaea* from California, with synonymical notes on the Genus *Ocnaea*. Ent. News 72:7-12.
- . 1968. Studies in neotropical Acroceridae, Part 1. A revision of *Arrhynchus* Philippi and a key to the genera of the *Ocnaea* branch of the Panopinae. Rev. Chilena Ent. 6:47-54.
- . 1972. A new Brazilian panopine species, *Exetasis eickstedtae*, reared from the theraphosid spider, *Lasiadora klugi* (Koch), with a description of its immature larval stages (Diptera: Acroceridae). Papéis Avulsos Zool. S. Paulo 26:73-82.

A New Species of *Macrobiotus* from Tierra del Fuego (Tardigrada: Macrobiotidae)

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A new tardigrade from Tierra del Fuego is described in this paper. This species has claws which are sufficiently different from typical *Macrobiotus* claws to strongly suggest that it represents an undescribed genus. However, the difference is only an extreme modification of a single character which is normally somewhat variable in other species of *Macrobiotus*, and this species is tentatively placed there.

Macrobiotus tridigitus Schuster, NEW SPECIES

(Figs. 1, 2)

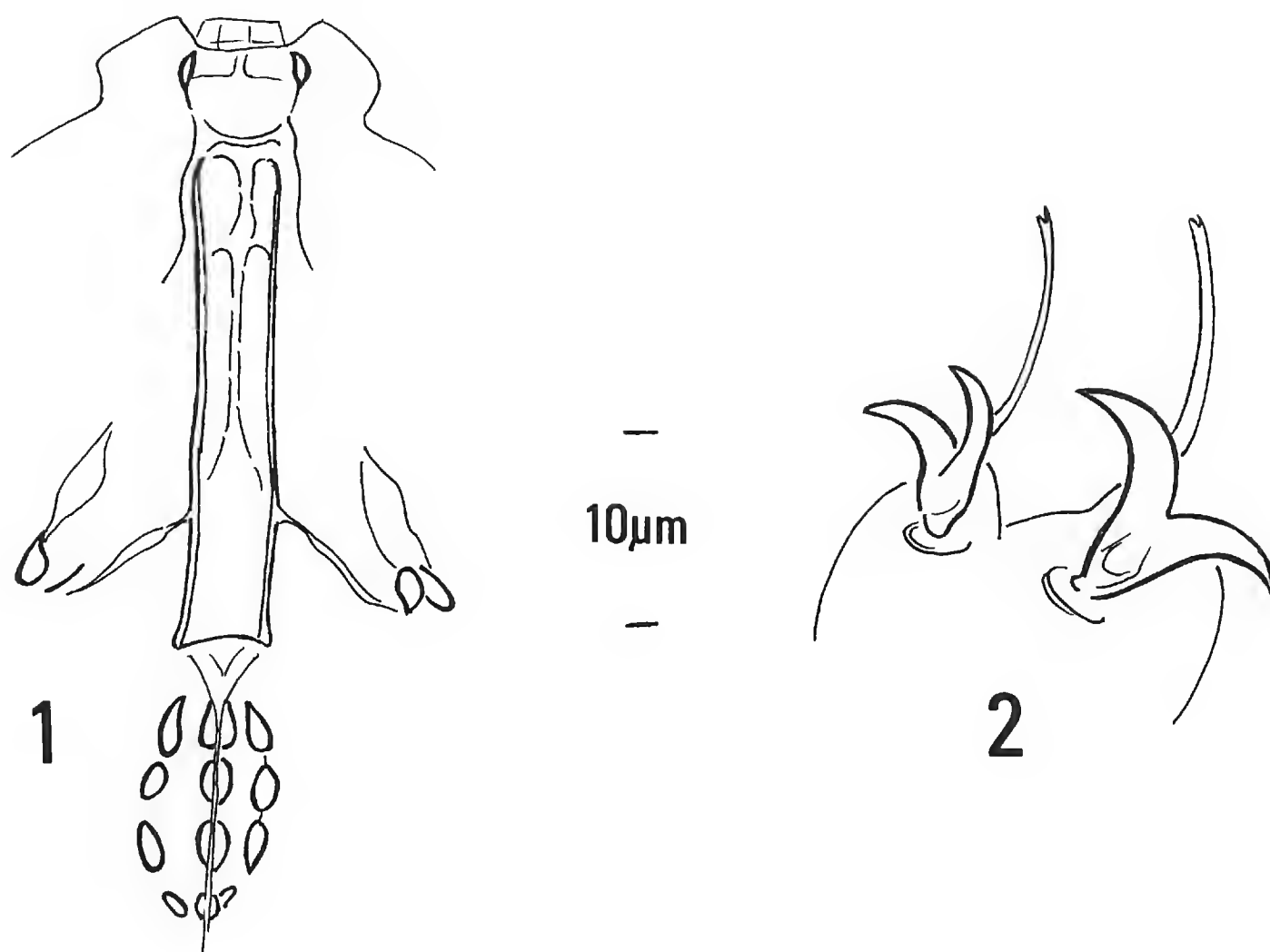
Holotype.—Total length, from extended buccal opening to end of claws IV, 246 μm . Cuticle smooth, pores not evident by phase microscopy. Without eye pigmentation. Buccal apparatus (Fig. 1) 47 μm long; tube including buccal ring 34 μm ; placoid strands 13 μm ; tube with long ventral lamina. Pharynx contains apophyses, 3 macroplacoids with first and third of similar size and perceptibly longer than second, and microplacoid. Claw sequence 2, 1, 1, 2 (Fig. 2), accessory points of primary claw branches very long, not attached along claw margin; lunulae large, without teeth.

Type series.—Holotype and 1 paratype from Sierra Martial, Tierra del Fuego, ARGENTINA, in cryptogams, tree line (2000–2500 feet), I-19-1979, Arthur M. Shapiro. Deposited with the Department of Entomology, University of California, Davis.

Etymology.—Latin; masculine, *tres*, three; *digitus*, finger, descriptive of the claws.

Discussion.—The buccal ring of this species is either longitudinally grooved or completely divided into buccal lamellae but the exact structure cannot be determined from the available specimens. If ten buccal lamellae do exist, the only departure from typical *Macrobiotus* species (see Ramazzotti, 1972, and Schuster *et al.*, 1980) is the extreme elongation of the cuticle forming the accessory points of the primary claw branches. Normally the cuticle is attached along the edge of each primary claw branch and terminates in two small, subapical spines. The accessory points of this species terminate as thin cuticular processes that arise at the base of the primary branch, are much longer than the branch, and are not attached to it. These processes seem to be quite inflexible and probably provide some mechanical advantage to locomotion. They do distinguish *M. tridigitus* from all other *Macrobiotus*.

¹ I appreciate having the opportunity to participate in this tribute to the systematic contributions by Dr. Richard M. Bohart.



Figs. 1, 2. *Macrobiotus tridigitus*. 1, detail of buccal tube and placoids. 2, claws of leg II.

LITERATURE CITED

- Ramazzotti, G. 1972. Il Phylum Tardigrada. Seconda edizione aggiornata. Mem. Ist. Ital. Idrobiol. 28:1-732.
- Schuster, R. O., D. R. Nelson, A. A. Grigarick, and D. Christenberry. 1980. Systematic Criteria of the Eutardigrada. Trans. Amer. Micros. Soc. 99:284-303.

New North American *Pulverro* Pate with a Key to the Species (Hymenoptera: Sphecidae)

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California 93702.

Pulverro Pate is a member of the sphecid subfamily Pemphredoninae and its distribution is limited to western North America. These wasps are relatively small, mostly black and average 3 mm in length. They are predaceous on thrips and usually nest in sandy ground or soil that has been recently disturbed (Bohart and Grissell, 1972). Most species occur in arid areas of the west where they visit native flowers but show no particular specificity.

Pulverro contains 11 species, 6 previously described (*monticola* Eighme, *costano* Pate, *mescalero* Pate, *constrictus* (Provancher), *laevis* (Provancher), and *columbianus* (Kohl)) and 5 described in this paper (*boharti*, *patei*, *eighmei*, *coconino* and *mexicanus*). In Pate's second publication on the subtribe Ammoplanina (1939) he suggested the presence of two species groups in *Pulverro* but did not set them apart with characters. With the collection of additional specimens and new species, it appears that there are two fairly well defined species groups, the *mescalero* group and the *laevis* group. The *mescalero* group contains 5 species and is distinguished by the following: males; mandible with ventral edge simple, without tooth or carina, narrowing apically (Fig. 5); scutum with apicolateral corners squared (Fig. 13), extending forward over pronotum (Fig. 2); females; scutum same as males; frons with tumid areas basad of antennal sockets, median area usually depressed. The *laevis* group contains 6 species and is distinguished by the following: males; mandible with ventral edge having a prominent tooth medially or carina apically (Figs. 3, 4); scutum with apicolateral corners rounded (Fig. 12), not extending forward over pronotum (Fig. 1); females; scutum same as males; frons without tumid areas basad of antennal sockets; median area forming a smooth carina, usually terminating approximately halfway between median ocellus and basal edge of clypeus.

In this paper I describe 5 new species and provide a key to the valid species. A later paper will present a revision of *Pulverro* and discuss relationships between the species.

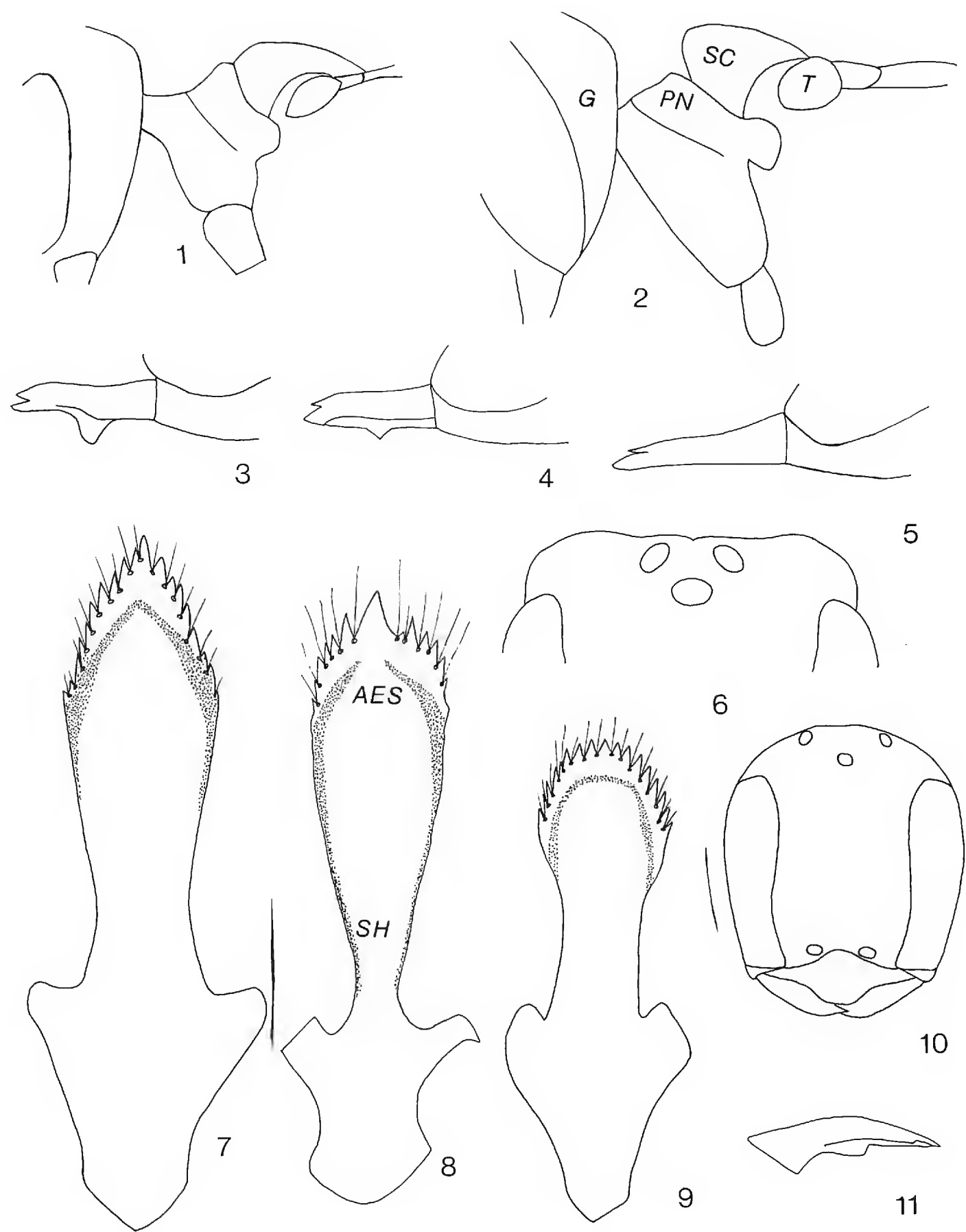
KEY TO MALE *PULVERRO*

1. Mandible with ventral edge simple, without tooth or carina, narrowed apically (Fig. 5); scutum with apicolateral corners squared (Fig. 13), extended forward over pronotum (Fig. 2) (*mescalero* group) 2
- Mandible with ventral edge having prominent tooth medially (Figs. 3, 4) or carina apically, mandible enlarged apically; scutum with apicolateral corners rounded (Fig. 12), not extended forward over pronotum (Fig. 1) (*laevis* group) 6

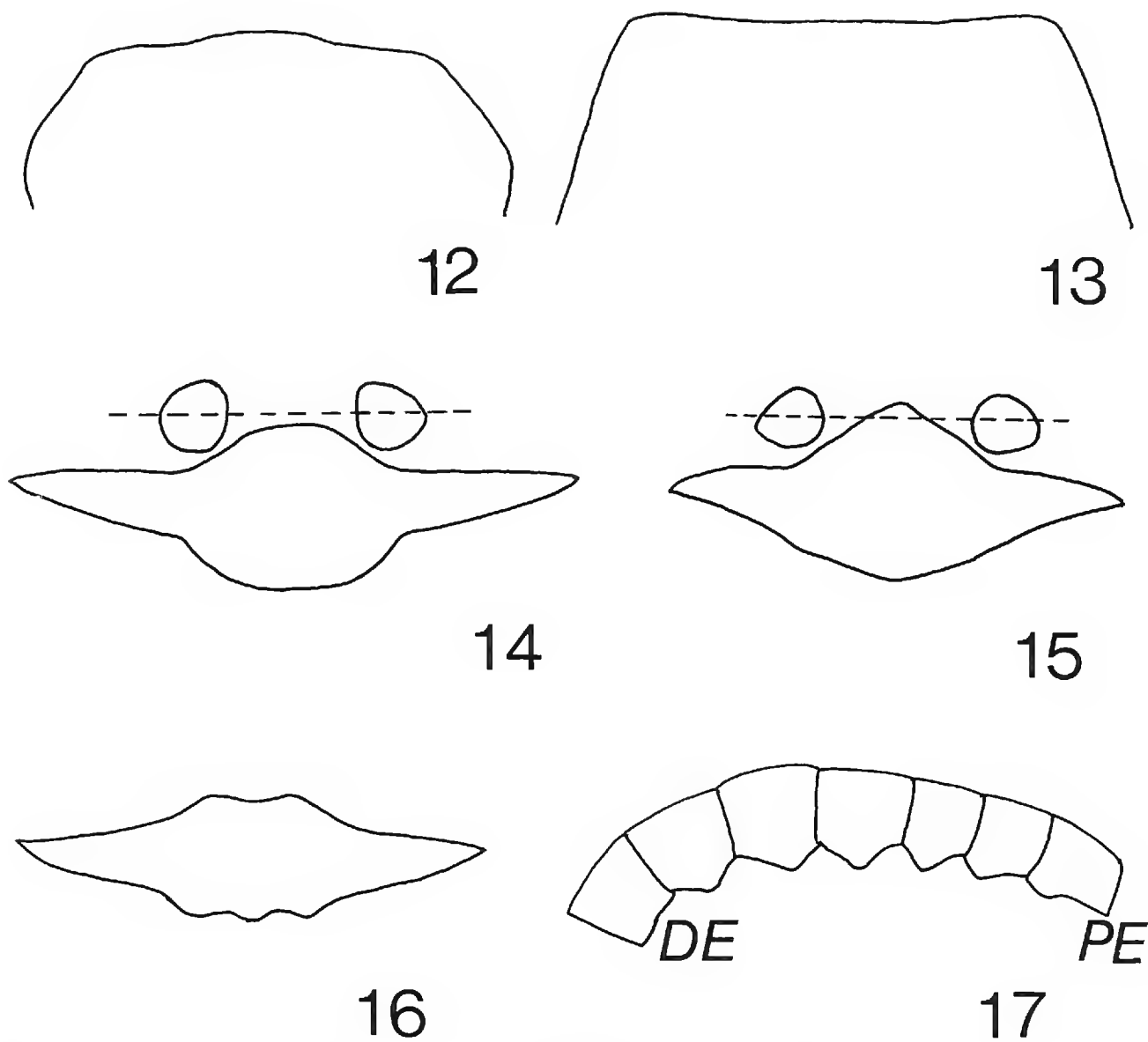
- 2. Mandible with medioventral translucent tooth on inner margin (Fig. 11) 3
 - Mandible without medioventral translucent tooth on inner margin ... 4
- 3. Clypeus mediobasally with prominent angular process; abdominal sternum 8 occasionally with apicomedian tooth larger than lateral teeth (as in Fig. 8) *columbianus* (Kohl)
 - Clypeus mediobasally with small, nipple-like projection, abdominal sternum 8 with teeth approximately equal size (as in Fig. 7) *monticola* Eighme
- 4. Antennal flagellomeres 1-5 (at least) nodulate ventrally (Fig. 17) 5
 - Antennal flagellomeres not nodulate ventrally *mescalero* Pate
- 5. Clypeus broadly triangular, lacking basomedial nipple-like projection; flagellomeres ventrally mostly brown to black *mexicanus* N. J. Smith
 - Clypeus narrowly triangular, with basomedial nipple-like projection; flagellomeres ventrally entirely yellow *boharti* N. J. Smith
- 6. Clypeus basally with highly polished area 7
 - Clypeus basally without polished area 8
- 7. Sterna 4 and 5 with erect tufts of white hair when viewed laterally; sternum 5 with median, tooth-like carina projecting distally; sternum 8 rounded apically (Fig. 8) *coconino* N. J. Smith
 - Sterna 4 and 5 without erect tufts of hair; sternum 5 without median tooth-like carina; sternum 8 pointed apically (Fig. 7) *constrictus* (Provancher)
- 8. Mandibles with prominent tooth medioventrally (Figs. 3, 4); clypeus apicolaterally with sharp points 9
 - Mandibles with only a low carina apicoventrally; clypeus apicolaterally without sharp points 10
- 9. Mandible with ventral tooth large and rounded apically (Fig. 3); clypeus polished, without silver hair *laevis* (Provancher)
 - Mandible with ventral tooth moderate in size and pointed apically (Fig. 4); clypeus not polished, with silver hair *costano* Pate
- 10. Clypeus apically with 3 serrations (Fig. 16), mediobasally without a nipple-like projection; notauli present but obscure ... *eighmei* N. J. Smith
 - Clypeus apically truncate, mediobasally with a nipple-like projection; notauli deeply impressed *patei* N. J. Smith

KEY TO FEMALE *PULVERRO*

- 1. Scutum with apicolateral corners squared (Fig. 13), extended over pronotum (Fig. 2); frons with tumid areas above antennal sockets, median area usually depressed (*mescalero* group) 2
 - Scutum with apicolateral corners rounded (Fig. 12), not extended over pronotum (Fig. 1); frons without tumid areas above antennal sockets, median area with low carina, usually terminating about halfway between median ocellus and clypeus (*laevis* group) 5
- 2. Upper frons punctures 1-3 puncture diameters apart, interspaces usually polished 3
 - Upper frons punctures no more than 1 diameter apart, usually less, interspaces dull 4



Figs. 1-11. 1, 2, lateral view of scutum and pronotum; 1, *P. costano*, female; 2, *P. monticola*, male, G—gena, SC—scutum, T—tegula, PN—pronotum. 3-5, male, lateral view of mandible and lower part of head; 3, *P. laevis*; 4, *P. costano*; 5, *P. monticola*. 6, *P. mexicanus*, male, front view of head. 7-9, male sternum 8, ventral view; 7, *P. constrictus*; 8, *P. coconino*, AES—apical end of sternum, SH—shaft; 9, *P. costano*. 10, *P. patei*, female, face. 11, *P. monticola*, male, dorsal view of mandible.



Figs. 12-17. 12, 13, dorsal view of scutal shoulders, male; 12, *P. costano*; 13, *P. monticola*. 14, 15, front view of clypeus and antennal sockets, female; 14, *P. constrictus*; 15, *P. coconino*. 16, *P. eighmei*, male, front view of clypeus. 17, *P. mexicanus*, male, lateral view of basal flagellomeres; DE—distal end, PE—proximal end.

- 3. Clypeus evenly covered with sparse silvery pubescence, head obviously wider than long (0.88 as long as wide, $n = 3$) *mescalero* Pate
- Clypeus medially highly polished, sparse silver pubescence laterally, head about as long as wide (1.00 as long as wide, $n = 3$)
..... *boharti* N. J. Smith
- 4. Frons with tumid areas strongly delineated; head much wider than long (0.82 as long as wide, $n = 3$); clypeal disc wider than long, slightly polished *monticola* Eighme
- Frons with tumid areas slightly delineated; head slightly wider than long (0.96 as long as wide, $n = 3$); clypeal disc about as long as wide, highly polished *columbianus* (Kohl)
- 5. Clypeus globose, without silvery pubescence, polished; occipital carina present ventrally 6
- Clypeus slightly convex, somewhat flattened, covered with silvery pubescence; occipital carina absent or evanescent ventrally 8

6. Upper frons sparsely punctate, polished, concave; scutum flattened, polished, notauli deeply impressed *patei* N. J. Smith
- Upper frons densely punctate, not polished, somewhat convex; scutum convex, not polished, notauli moderately impressed 7
7. Frontal carina sharp; species collected in interior areas of northern and central California *costano* Pate
- Frontal carina evanescent; species collected along southern California coast *laevis* (Provancher)
8. Stigma light brown to yellow; frontal carina evanescent, scapal basins not well differentiated; occipital carina evanescent ventrally
- *eighmei* N. J. Smith
- Stigma dark brown to black; frontal carina and scapal basins well differentiated; occipital carina absent ventrally 9
9. Clypeus extended dorsad past midline of antennal sockets (Fig. 15), with sparse silvery pubescence, apical half often yellow-brown; northern Arizona and southern Utah *coconino* N. J. Smith
- Clypeus not extended dorsad past midline of antennal sockets (Fig. 14), with moderate silvery pubescence, only tip yellow-brown; mostly southern California deserts *constrictus* (Provancher)

***Pulverro boharti* N. J. Smith, NEW SPECIES**

Holotype male.—Length 3 mm. Black; mouthparts, antennae ventrally, foretibia, mid and hindtibia at knees, foretarsi and mid and hindtarsi at base yellow. Wing veins brown, stigma dark brown. Body with sparse hair, abdominal segments with sparse hair, clypeus and lower frons with sparse silver pubescence. Mandibles bidentate, ventrally with apical half not having low carina, narrowing apically; inside ventral margin without hyaline tooth. Clypeus medially subtriangular, apical edge truncate, mediobasal edge with nipple-like projection. Lower frons with low, broad frontal carina medially; scapal basins slightly differentiated, shallow; upper frons rugose. Antennae with basal flagellomeres nodulate ventrally (as in Fig. 17); pedicel strongly nodulate. Midventral line approximately $\frac{1}{3}$ length of forecoxa.

Scutum with apicolateral corners moderately squared and slightly extended over pronotum (as in Figs. 2, 13), dorsal surface convex and moderately hairy, surface slightly rugose; notauli moderately impressed. Propodeum dorsally with two parallel carinae; reticulate between. Mesopleuron polished, setigerous punctures sparse. Sternum glabrous, highly polished.

Sternum 8 apically serrate and rounded, moderately hairy (as in Fig. 9).

Female.—Length 3.5 mm. Markings as in male. Head approximately as long as wide (1.00, $n = 3$). Mandibles as in male. Clypeus broadly and slightly concave apicomediaally; clypeal disc with sparse silver pubescence laterally, highly polished medially. Lower frons with tumid areas basad of antennal sockets moderately developed, converging basomedially, medially with shallow depression; scapal basins strongly defined, lightly silvered apically. Frons with small, shallow, central, circular depression. Upper frons with setigerous punctures moderately spaced (2–

3 puncture diameters apart), polished between in Wyoming specimens, faintly rugose in Arizona specimens.

Scutum with apicolateral corners moderately squared and extended over pronotum (as in Figs. 2, 13); notauli obscure; scutum dorsally convex and rugose. Pygidium trigonal and margined by sharp carina with few punctures laterally.

Diagnosis.—*P. boharti* is a member of the group *mescalero*. Major distinguishing characters of the male are the nipple-like projection on the basomedial edge of the clypeus, clypeus with sparse silver pubescence; basoflagellomeres nodulate ventrally (as in Fig. 17) and sternum 8 rounded (as in Fig. 9). Males of *boharti* most closely resemble those of *mescalero* and *mexicanus*. All three lack the translucent tooth on the inner medioventral margin of the mandible but *mescalero* lacks the nodulate basoflagellomeres common to *boharti* and *mexicanus*. The nipple-like projection of the clypeus of *boharti* males separates the species from *mexicanus*, and the latter has a rectangular occipital area behind the compound eyes.

Major female distinguishing characters are: clypeal disc polished medially and with silver pubescence laterally; head approximately as long as wide and upper frons (at least in the Wyoming specimens) sparsely punctate and polished between punctures. Females of *mescalero* are most closely related to those of *boharti*. They are related by their upper frons punctures being only 1–2 puncture diameters apart and polished between punctures. *P. boharti* differs from *mescalero* in having a medially polished clypeus which is sparsely silvered laterally and the head is about as long as wide. *P. mescalero* lacks the polished area on the clypeus and the head is wider than long.

Type material.—Holotype ♂ (UCD): WYOMING, *Sweetwater Co.*, 12 mi. s. Green River, 28 July 1969, R. M. Bohart. Paratypes, 15 ♂, 1 ♀, same data as holotype. Other localities (all specimens collected by P. H. Timberlake, UCR, unless otherwise stated): ARIZONA: *Navajo Co.*: Hotevilla, 27 Sept. 1977, 4 ♂, 2 ♀ (R. M. Bohart, UCD); Hotevilla, 30 Aug. 1976, 1 ♂, 1 ♀ (R. M. Bohart, UCD); 3 mi. w. Old Oraibi, 24 Sept. 1964, 1 ♂, 1 ♀; 23 mi. n. Indian Wells, 14 Sept. 1960, 1 ♀. *Coconino Co.*: Tuba City, 24 Sept. 1964, 10 ♂, 6 ♀. *Apache Co.*: 16.6–51.5 mi. se. Round Rock, 28 Aug. 1961, 9 ♂, 11 ♀; 18 mi. sw. Ganado, 29 Aug. 1967, on *Gutierrezia microcephala*, 1 ♂. NEW MEXICO: *McKinley Co.*: 29 mi. s. Gallup, 17 Sept. 1968, 1 ♂; 8 mi. sw. Ramah, 17 Sept. 1968, 1 ♂. UTAH: *Uintah Co.*: Bonanza, 8–30 Aug. 1975, 2 ♂, 1 ♀ (G. E. Bohart, USU). *Duchesne Co.*: Fruitland, 30 Aug. 1949, 1 ♀ (G. F. Knowlton, USU). COLORADO: *Rio Grande Co.*: 5 mi. nw. South Fork, 14 Aug. 1978, 9 ♂ (T. Griswold, personal).

Etymology.—*P. boharti* is named after R. M. Bohart in recognition of his systematic work on the ammoplanines and the many specimens and new species that he has collected over the years.

***Pulverro coconino* N. J. Smith, NEW SPECIES**
(Figs. 8, 15)

Holotype male.—Length 3.25 mm. Black; mouthparts yellow; foretibia, mid and hindtibia at knees and all tarsi burnished yellow. Wing veins light brown, stigma dark brown. Body mostly glabrous but tiny hairs can be found over most

parts. Clypeal disc with sparse silver pubescence. Mandibles bidentate apically; ventrally with carina developed into 2 (one larger than the other), small, blunt teeth medially. Clypeus with median triangular platform, truncate apically, surrounded laterobasally by highly polished vertically rising ridge, smoothly produced mediobasally to extend well basad and above midline of antennal sockets (as in Fig. 15). Lower frons flat medially, scapal basins not differentiated; upper frons rugose, convex. Antennae entirely dark brown; basal flagellomeres slightly nodulate ventrally. Midventral line of head approximately one-fourth length of forecoxa.

Scutum with apicolateral corners rounded and not extending over pronotum, dorsal surface convex with setigerous punctures moderate (1–2 puncture diameters apart) and polished between. Propodeum dorsal surface with two subparallel carinae, reticulate between. Abdominal sterna 4 and 5 with median erect tufts of hair when viewed laterally; sternum 7 with erect tuft of hair easily visible laterally, pointing back toward tufts on sterna 4 and 5; sternum 5 with median carina produced into tooth pointing distally.

Sternum 8 serrate, subtruncate apically with a large median tooth, not obviously spatulate, moderately hairy (Fig. 8).

Female.—Length 3.25 mm. Markings as in male except antennae almost entirely yellow, clypeus burnished yellow on apical half. Clypeus sparsely silvered. Mandibles bidentate apically and without ventral carina or teeth. Clypeus medially with slightly raised trigonal platform, apically evenly rounded, convex, medio-basally produced basad of midline of antennal sockets (Fig. 15). Lower frons medially with low, sharp carina, ending approximately halfway between median ocellus and clypeus; scapal basin shallow, moderately defined; upper frons with setigerous punctures moderate (1–2 puncture diameters apart) and polished between. Midventral line of head long due to absence of occipital carina.

Scutum as in male. Propodeum dorsally with subparallel carinae weakly developed. Abdomen ventrally without distinguishing characters. Pygidium trigonal, margined with sharp carina, punctate evenly over entire surface.

Diagnosis.—*P. coconino* is a member of the *laevis* group. Distinguishing characters for male *coconino* are the mediobasal polished area on the clypeus, the unique erect tufts of hair on sterna 4, 5 and 7, and the tooth-like median carina on sternum 5. The closest relative is *P. constrictus*, based on the shared mediobasal polished area of the clypeus found in *coconino* but *constrictus* lacks the abdominal characters.

Distinguishing characters for female *coconino* are the apical half of clypeus burnished yellow and sparsely silvered and clypeus extending upward between antennal sockets (Fig. 15). *P. coconino* and *constrictus* share a flattened, slightly convex, sparsely silvery pubescent clypeus and the absence of the occipital carina ventrally. The clypeus of *constrictus* is entirely black and the mediobasal area is somewhat truncate, not extended past the midline of the antennal sockets (Fig. 14).

Type material.—Holotype ♂ (CAS): ARIZONA, *Coconino Co.*, Tuba City, 24 Sept. 1964, on *Chrysothamnus*, P. H. Timberlake. Paratypes: 6 ♂, 5 ♀ (7 with same data as holotype): ARIZONA: *Coconino Co.*: 26 mi. e. Tuba City, 24 Sept. 1964, on *Chrysothamnus*, 3 ♂, 1 ♀ (P. H. Timberlake, UCR). Numerous other specimens

were studied from Emery and Wayne Counties in southern Utah collected at approximately the same time of year by F. D. Parker, D. Viers and T. Griswold.

Pulverro eighmei N. J. Smith, NEW SPECIES
(Fig. 16)

Male holotype.—Length 3 mm. Black; mouthparts, ventral side of antennae yellow; foretibia, mid and hindtibia at knees and all tarsi burnished yellow. Wing veins hyaline to light yellow; stigma brown to yellow (variable in paratypes). Clypeus with sparse to moderate silver pubescence; scapal basins with sparse silver pubescence apically. Mandible bidentate apically; apicoventrally with low carina, mandible widened apically; inside edge without tooth. Clypeus and median area triserrate apically (Fig. 16), with sparse silver pubescence, moderately convex discally. Lower frons without frontal carina, but with flat, narrow, smooth line from clypeus to median ocellus, scapal basins shallow, not well defined; upper frons convex, rugose. Antennal flagellomeres mostly terete, appearing slightly nodulate ventrally in some specimens, light brown dorsally. Midventral line approximately $\frac{1}{3}$ length of forecoxa. Occipital carina ventrally evanescent, actually appearing recessed.

Scutum with apicolateral corners rounded (as in Fig. 12), not extended forward over pronotum (as in Fig. 1); dorsal surface convex, rugose; notauli obscure. Mesopleuron shiny but not smooth, somewhat rugose. Propodeum dorsally with numerous, low, longitudinal carinae.

Sternum 8 slightly spatulate, apically serrate and sparsely hairy.

Female.—Length 3.5 mm. Markings as in male except stigma only rarely light brown. Mandibles as in male except apicoventrally without carina. Clypeus convex discally with sparse silver pubescence, slightly convex and burnished yellow apically. Lower frons with low, broad carina medially, ending approximately $\frac{2}{5}$ distance between clypeus and median ocellus, changing to smooth line at that point; upper frons polished but with setigerous punctures dense (equal to or less than one puncture diameter apart); scapal basins shallow, rather broad, tumidity basad of antennal sockets absent. Midventral line as in male; ventral, occipital carina as in male. Scutum, propodeum and mesopleuron as in male. Pygidium margined by sharp carina, medially with longitudinal tumid area, laterally impunctate.

Diagnosis.—*P. eighmei* belongs to the *laevis* group. Major distinguishing characters for male *eighmei* are the tri-serrate clypeus and the evanescent, recessed ventral area of the occipital carina. The tri-serrate clypeus alone will distinguish *eighmei* from all other species in the genus.

Distinguishing female characters are the yellow stigma and the evanescent recessed occipital carina. The yellow stigma is unique and will distinguish this sex from all other *Pulverro* females.

P. eighmei does not appear to have close relatives, however the evanescent, recessed occipital carina in the female suggests a relationship with *coconino* and *constrictus* which have lost their occipital carina.

Type material.—Holotype ♂ (UCD): CALIFORNIA, San Bernardino Co., Kramer Hills, 8 May 1978, on *Machaeranthra tortifolia*, R. W. Brooks. Paratypes: 86 ♂, 63 ♀, same data as holotype. Numerous other specimens have been collected

throughout the desert regions of southern California, eastern Nevada, western Arizona and northern Baja, California.

Etymology.—*P. eighmei* (pronounced ā-me-ī) is named after Dr. Lloyd E. Eighme, who has contributed significantly to work on *Pulverro*. Dr. Eighme also supplied valuable taxonomic information and specimens as well as criticism on the manuscript.

***Pulverro mexicanus* N. J. Smith, NEW SPECIES**

(Figs. 6, 17)

Male holotype.—Length 3 mm. Black; mouthparts yellow; foretibia, mid and hindtibia at knees, fore and midtarsi burnished yellow. Wing veins dark brown, stigma black. Clypeus and apical edge of scapal basins with dense silver pubescence. Mandibles bidentate apically; apicoventrally lacking the low carina; inner median edge lacking hyaline tooth. Clypeus medially with pentagonal-shaped platform, concave discally, very slightly concave apically. Lower frons medially with broad carina, ending approximately halfway between clypeus and median ocellus; scapal basins sharply defined; upper frons convex, rugose. Occipital region boxlike, extending straight back from compound eye before turning to middle (Fig. 6). Antennal flagellomeres ventrally with basal 6 nodulate (Fig. 17). Mid-ventral line approximately half length of forecoxa.

Scutum with apicolateral corners squared and extending forward over pronotum (Figs. 2, 13), convex dorsally, rugose; notauli moderately excised. Mesopleuron shiny but not polished, slightly rugose. Propodeum dorsally with numerous, longitudinal, low carinae. Female unknown.

Diagnosis.—*P. mexicanus* is a member of the *mescalero* group. Major distinguishing characters are: flagellomeres 1–6 ventrally nodulate (Fig. 17); clypeus medially with a pentagonal platform; and occipital area in back of the compound eyes is rectangular (Fig. 6). *P. boharti* and *mescalero* are the nearest relatives, their relationship being discussed under the *boharti* diagnosis. The last two major distinguishing characters will separate *mexicanus* from all other species of the genus. Females of *mexicanus* are not known but would probably resemble those of *mescalero* and *boharti*.

Type material.—Holotype ♂ (USU): MEXICO, *Oaxaca*, 3 mi. se. Yahuítlan, 17 Sept. 1974, G. E. Bohart & W. Hanson. Paratypes: 1 ♂, same data as holotype (UCD). MEXICO: *Coahuila*: Monclova, 21 Sept. 1974, 1 ♂ (G. E. Bohart & W. Hanson, USU).

Etymology.—*P. mexicanus*, known only from the 3 males listed above, was collected from two widely separated localities in Mexico, and is named for the country of origin.

***Pulverro patei* N. J. Smith, NEW SPECIES**

(Fig. 10)

Holotype male.—Length 3 mm. Black; mouthparts, foretibia, mid and hindtibia at knees and all tarsi yellow. Wing veins light brown, stigma dark brown. Body mostly glabrous; abdominal segments sparsely hairy, clypeus with moderate silver pubescence; lower frons and especially scapal basins with dense silver pubescence. Mandibles bidentate, ventrally with apical half having low carina; inner edge with small, hyaline tooth. Clypeus medially subtriangular, concave discally, apex lat-

erally with tiny, blunt teeth, mediobasally with nipple-like projection. Frons ridged medially, approximately halfway from clypeus to midocellus; scapal basins well defined, shallow; upper frons sparsely punctate but faintly rugose. Antennae entirely black, all segments terete. Midventral line between occipital carina and hypostomal carina approximately $\frac{3}{4}$ length of forecoxa.

Scutum with apicolateral corners rounded and not extending over pronotum (as in Figs. 1, 12); notauli deeply impressed; setigerous punctures sparse, minutely reticulate between. Propodeal dorsum reticulate with two, parallel longitudinal carinae. Mesopleuron with setigerous punctures sparse, highly polished between. Sternum 6 glabrous, highly polished.

Sternum 8 spatulate, serrate and with long hair.

Female.—Length 3 mm. Markings as in male except antennae are almost entirely yellow. Head appearing narrowed, longer than wide (Fig. 10). Mandibles lack low carina and hyaline tooth. Central clypeal disc roundly tumid and highly polished, basal edge extending between antennal sockets, apical edge truncate. Clypeus and frons without silver pubescence. Frons ridged medially, approximately $\frac{1}{3}$ distance from clypeus to midocellus; upper frons with setigerous punctures sparse, highly polished between; upper median area concave. Propodeum tricarinate. Pygidial plate trigonal and margined by sharp carina, with few punctures laterally.

Diagnosis.—*P. patei* belongs in the *laevis* species group. Unique in this species is the fact that males and females appear to be more closely related to different species in their respective sexes. Males, except for the species group characters, would appear to be close to *monticola* and *columbianus* because of the presence of a small hyaline tooth medioventrally on the inside of the mandible (as in Fig. 11) and a small, nipple-like projection mediobasally on the clypeus. Females on the other hand show a close affinity to *costano* and *laevis*, primarily due to the strongly tumid, polished disc on the clypeus much as in *costano* and *laevis*. Characters that definitely relate the male and female are the sparse setigerous punctures on the upper frons and scutum and the smooth, polished appearance of both areas, as well as deeply impressed notauli. Locality records also bear out their relationship.

Good distinguishing characters for the male are the antennae entirely black, terete; the basomedial nipple-like projection on the clypeus, and the highly polished scutum with its sparse, setigerous punctures and deeply impressed notauli. Distinguishing characters for the female: the tumid, polished clypeal disc, the highly polished upper frons with its sparse setigerous punctures and central concavity; the overall narrow appearance of the head (Fig. 10); the dorsally flattened scutum with its sparse setigerous punctures and polished appearance.

Type material.—Holotype ♂ (UCD): ARIZONA, Navajo Co., Hotevilla, 27 Sept. 1977, on *Chrysothamnus*, R. M. Bohart. Paratypes, 4 ♂, 1 ♀, same data as holotype. Other paratypes (all collected by P. H. Timberlake, UCR, unless stated otherwise): ARIZONA: Navajo Co.: Dinnebeta Wash, 30 Aug. 1976, 2 ♂ (R. M. Bohart, UCD); 3 mi. w. Old Oraibi, 24 Sept. 1964, on *Chrysothamnus*, 12 ♂, 17 ♀; 11 mi. n. Holbrook, 22 Sept. 1964, on *Gutierrezia lucida*, 1 ♂. Coconino Co.: Tuba City and 26 mi. e. Tuba City, 24 Sept. 1964, on *Chrysothamnus*, 5 ♂, 6 ♀. Apache Co.: 24 mi. nw. Concho, 25 Sept. 1964, on *Chrysothamnus*, 1 ♂, 1 ♀; 18 mi. sw. Ganado, 25 Sept. 1964, on *Baileya*, 1 ♂; Steamboat Canyon, 14 Sept. 1961, on *Chryso-*

thamnus, 1 ♂. UTAH: Kane Co.: 23 mi. e. Kanab, 23 Sept. 1964, on *Chrysothamnus*, 1 ♂; Glenn Canyon, 25 Sept. 1964, on *Gutierrezia lucida*, 1 ♂. Other specimens studied: NEW MEXICO: Socorro Co.: 3 mi. w. Bingham, 12 Sept. 1961, on *Baileya pleniradiata*, 29 ♂, 1 ♀ (2 ♂, coll. by P. D. Hurd, UCB). Lincoln Co.: 24 mi. w. Carrizozo, 12 Sept. 1961, on *Gutierrezia*, 5 ♂. De Baca Co.: Fort Sumner, 2 Oct. 1965, on *Gutierrezia*, 1 ♂ (G. E. Bohart, USU).

Etymology.—*P. patei* is named after V. S. L. Pate, a prolific worker on the Ammoplanina.

ACKNOWLEDGMENTS

I would like to thank the following museums and individuals for their generous loan of specimens: University of California at Riverside (UCR, P. H. Timberlake, S. Frommer), at Berkeley (CIS, J. Powell), and at Davis (UCD, R. Schuster); Utah State University (USU, G. E. Bohart, W. Hanson); Pacific Union College (PUC, L. Eighme); Terry Griswold (personal); U.S. National Museum (USNM, A. Menke); California Department of Food and Agriculture (CDFA, M. Wasbauer); Philadelphia Academy of Natural Sciences (ANSP, D. Otte); American Museum of Natural History (AMNH, M. Favreau); Canadian National Collection (CNC, L. Masner); and Cornell University (COR, L. Pechuman). Holotypes selected from U.C. Davis specimens are deposited at Davis. Holotypes from loaned specimens are deposited as stated for each species.

I would like to thank Professor Richard M. Bohart for all his advice and patience during this study. It could not have been accomplished without his previous work on the genus, his contribution of specimens and his generous sharing of personal research money for invaluable collection trips. Professors Robbin W. Thorp and Albert A. Grigarick also read the manuscript and made helpful comments. Others who were helpful in collecting specimens or making suggestions were Lloyd E. Eighme, Robert W. Brooks, Lynn S. Kimsey, Robert L. Kimsey and Larry D. French.

LITERATURE CITED

- Bohart, R. M., and E. E. Grissell. 1972. Nesting habits and larva of *Pulverro monticola*. Pan-Pac. Ent. 48:145–149.
- Pate, V. S. L. 1939. Studies in the pemphredonine wasps. II. Records and descriptions of new forms in the ammoplanoid complex from southwestern United States. Trans. Amer. Ent. Soc. 64: 373–420.

Taxonomic and Nomenclatural Studies on American Polistine Wasps (Hymenoptera: Vespidae)

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The paper is dedicated to my colleague Dr. Richard M. Bohart, with thanks for his encouragement and patient assistance over the past thirty years.

The recent monograph by Richards (1978) of the social wasps (except Vespinae) of the New World has done much to improve our understanding of the taxonomy of these wasps. Such a monumental work cannot be without errors, nor can all the taxonomic decisions made therein be final or universally accepted. Therefore, in the spirit of continuing and partially correcting the study so admirably initiated by Richards, I offer the following in the hope of further clarifying the taxonomy and nomenclature of some of these wasps.

Genus *Polistes* Latreille

Polistes is a large, cosmopolitan genus of social wasps. The increasing interest in the social behavior of wasps has focused on *Polistes* because species occur almost everywhere, the wasps themselves are relatively mild tempered, and nest activity takes place on a single exposed comb.

The taxonomy of *Polistes* is, however, less amenable to easy study: often the subtle differences between species have not been appreciated by earlier workers, whose species concepts were often broad enough to include several closely related species by modern criteria. Many species are apparently widespread, sometimes exhibiting a bewildering range of color variants. These are considered localized, or geographical, races or varieties and often have been formally named; some species have acquired a formidable clutter of supposed geographic subspecies. In some cases, these forms are truly nothing more than color variants. In others, they appear to be sympatric or allopatric sibling species. Often, morphological evidence is inconclusive and some decisions as to the status of a given form may be nothing more than intuitive.

Subgenus *Aphaniloferus* Meunier

POLISTES EXCLAMANS OF AUTHORS

Richards (1978) treated seven forms as geographical segregates of *P. exclamans*. This was in line with my own views on this wasp (Snelling, 1954, 1955, 1970). Previously the following have been considered subspecies of *P. exclamans*: *arizonensis* Snelling, *bahamensis* Bequaert and Salt (= *louisianus* Bequaert), *bilineolatus* Bequaert and Salt, *durangoensis* Snelling, *lineonotus* R. Bohart, *picturatus* Bequaert and Salt, as well as *exclamans* Viereck (*s. s.*). I no longer believe this interpretation to be correct. Rather, I am of the opinion that there are several species, morphologically almost identical, largely allopatric and, possibly, behav-

iorally different. Most of these forms are wholly allopatric and internally homogeneous. I now interpret the group as follows:

P. arizonensis **New status**

P. bahamensis **New status**

= *P. exclamans louisianus* (syn. by Snelling, 1955)

= *P. bahamensis bilineolatus* **New synonymy**

= *P. bahamensis picturatus* **New synonymy**

P. exclamans **New status**

= *P. exclamans durangoensis* **New synonymy**

= *P. instabilis coahuilae* **New synonymy**

P. lineonotus **New status**

The form that occurs in southern Arizona and adjacent Mexico was originally described as *P. e. arizonensis*. Throughout its range, this is a remarkably consistent wasp and its color pattern exhibits no tendency to vary toward the richer markings of *P. exclamans* to the east nor toward *P. lineonotus* in Lower California. The head and body are reddish-brown, without mesonotal stripes and with very narrow apical fasciae on the first to third terga. Both *P. exclamans* and *P. lineonotus* have abundant yellow marks on the thorax, including longitudinal mesonotal stripes in *P. lineonotus*, and broad fasciae on all the abdominal terga and most sterna.

In addition to the characteristic color pattern, *P. arizonensis* differs from *P. exclamans* in the more sharply lobate humeral angle of the pronotal keel (as in Fig. 2, versus Fig. 4) and the narrower first tergum (about 0.85–1.00 times as wide as long) which is distinctly depressed beyond the middle when viewed in profile (much as in Fig. 1, versus Fig. 3). Very short (0.02–0.03 mm long) hairs are present on the eyes and are sufficiently abundant to be easily visible at 100× magnification. A very few hairs may be present on the eyes of *P. exclamans*, but these are consistently less than 0.01 mm long and easily overlooked at 100× magnification.

In the more southern parts of its range in Mexico, *P. exclamans* is represented by a color phase which is strikingly similar to *P. arizonensis*. The body is wholly ferruginous, except for the following yellow marks: narrow inner orbital stripe; narrow postorbital line; line or pronotal keel and on scutellum and metanotum; very narrow submedian pair of propodeal stripes; narrow distal fasciae on first three terga and second and third sterna. The wings are yellowish brown. I have seen specimens of these from the States of Jalisco (Guadalajara and Jocotopec), Hidalgo (14 mi NW Ixmiquilpan) and Guanajuato (Roque). I have also examined specimens intermediate between this form and more typical *P. exclamans* from Zacatecas (Ojo Caliente, Nochistlan) and Guanajuato (64 km SE La Saucedá).

In 1955 I described *P. e. durangoensis* from a few specimens from the States of Durango and Chihuahua, Mexico. They differed from the typical form in possessing greater amounts of black on the thorax and in the more extensively yellow abdomen. This variant is a trivial one and is synonymized here. Richards (1978) described *P. instabilis coahuilae* from two specimens from Las Delicias, Coahuila, Mexico. I have examined these specimens; in my opinion they are of the same color phase as *P. e. durangoensis* and, therefore, also a synonym of *P. exclamans* (**New synonymy**).

Bohart (1949) described *P. e. lineonotus* from Lower California, where it is

common. Geographically isolated from all its more closely related congeners, this wasp represents a self-consistent population. Although variable in the expression of the markings, they do not tend toward those of either *P. exclamans* or *P. arizonensis* and I believe this wasp should be accorded specific status.

The wasp here called *P. bahamensis* occurs in the Bahamas and Florida; it ranges sporadically along the Gulf Coast to New Orleans, Louisiana. Parts of its range in Florida and Louisiana are sympatric with that of *P. exclamans*. In these areas there is no evidence among the several hundred specimens that I have seen that the two forms hybridize. It is largely on this basis that I feel compelled to regard *P. bahamensis* as a separate entity.

The two remaining forms, *P. bahamensis bilineolatus* and *P. b. picturatus*, are localized, insular variants of *P. bahamensis*. Although each does differ slightly from *P. bahamensis* in the extent of yellow markings, neither is consistently marked on any of the islands and some specimens, which, on the basis of locality should be one or the other subspecies, are marked like typical *P. bahamensis*. Under these circumstances, I can see neither need nor justification for treating these variants as subspecies.

Polistes dominicus (Vallot)

Vespa dominica Vallot, 1802:173.

Polistes cincta Lepeletier, 1836:522. ♀. Preoccupied, **New synonymy.**

Polistes cinctus cinctus: Richards, 1978:478. ♀, ♂.

Polistes cinctus subsp. *barbadensis* Richards, 1978:479. ♀. **New synonymy.**

This is the wasp previously treated as *Polistes cinctus* by various authors. Long unnoticed is the fact, pointed out to me by A. S. Menke (pers. comm.), that *P. cinctus* is preoccupied by *Vespa cincta* Drury (1770), a synonym of *P. annularis* (Linne). The older name of Vallot is based on specimens figured by Réamur (1742 6: pl. 14, figs. 9 & 10). The Réamur specimens were presumably from Santo Domingo and apparently are no longer in existence. Among the Lesser Antillean wasps, only the present species matches the figures at all well.

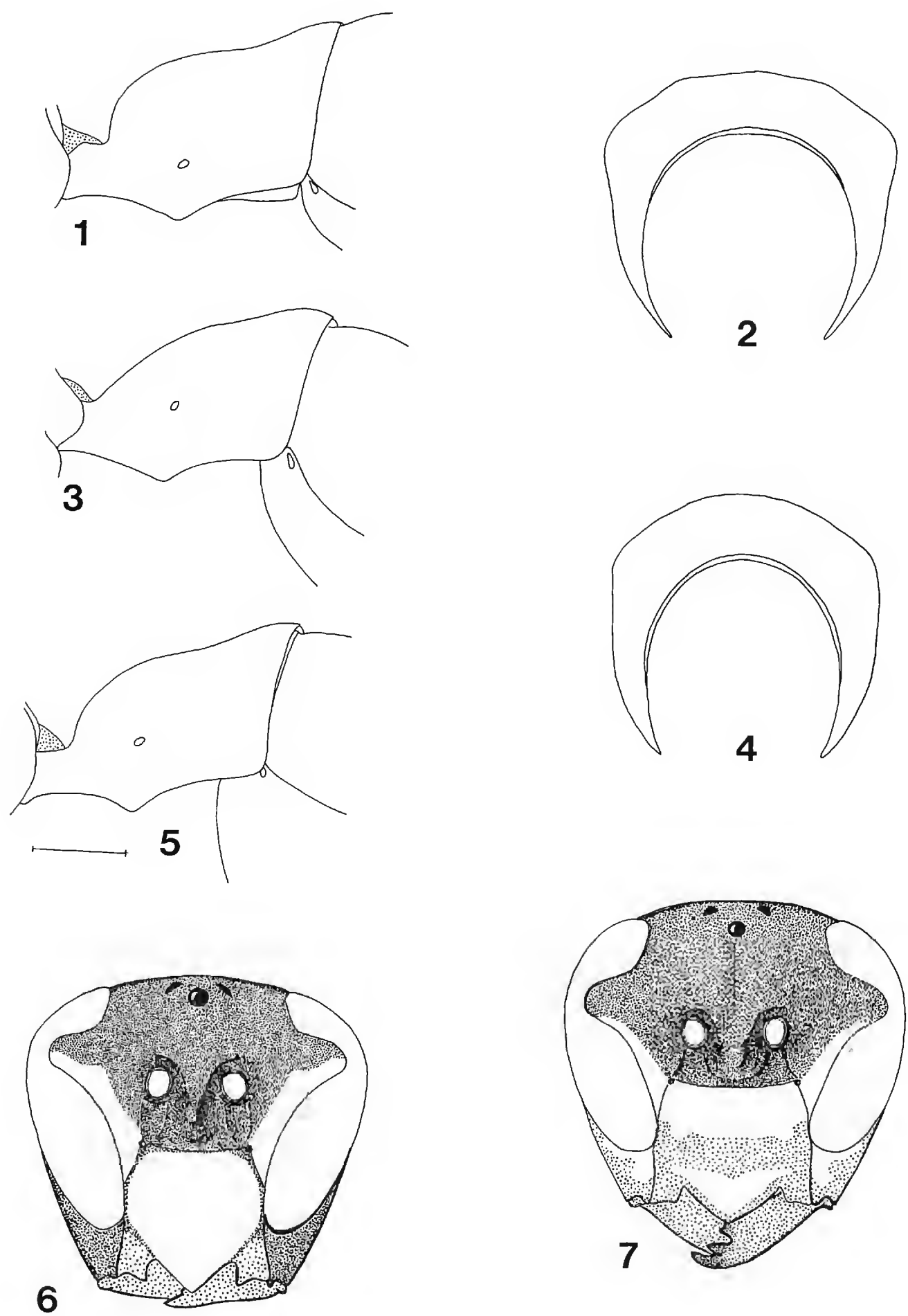
In the absence of verifiable original material, and in order to stabilize the nomenclature, a female **Neotype** is here designated which agrees with the characteristics cited by Richards (1978) for *P. cinctus cinctus*. The neotype is from St. Pierre, Martinique, 23 April 1965 (D. R. Davis) and is in the USNM. Additional specimens, all from Martinique, are neoparatypes and deposited in AMNH, LACM and USNM.

The form from Barbados, described as *P. cinctus* subsp. *barbadensis*, is a minor color variant, here placed in synonymy. In addition to Martinique and Barbados, I have seen material of *P. dominicus* from St. Kitts, Montserrat, St. Vincent, Sta. Lucia and Trinidad. Richards (1978) recorded *P. c. barbadensis* from Mustique and Carriacou Islands.

Polistes bequaertellus Snelling, NEW SPECIES

(Figs. 1, 2)

Diagnosis.—Known from females only. Morphologically most similar to *P. exclamans*, but differs in the laterally depressed pronotal keel (Fig. 2) and the



Figs. 1-7. *Polistes* spp. 1, 2, *P. bequaertellus*, profile of first tergum and frontal view of pronotal collar. 3, 4, *P. exclamans*, same. 5-7, *P. boharti*, profile of first tergum, frontal view of head of male and female. Scale line = 1.0 mm.

more slender first tergum, which is distinctly depressed beyond mid-length when viewed in profile (Fig. 1); eyes without erect hairs.

Description female holotype.—Measurements (mm): Head width 4.00; head length 3.54; wing length 17.0; total length 18.0.

Structurally almost identical to *P. exclamans*, to which it will run in Richards' (1978) key; pronotal keel distinctly depressed on either side of the humeral angle (Fig. 2); first tergum (Fig. 1) slender ($1.2\times$ longer than wide) and, in profile, is distinctly less convex than in *P. exclamans* and depressed at about the distal one-third; eyes without erect hairs.

Integument generally reddish brown, the following yellow: head, except supra-clypeal area and ocellar area; broad stripe confluent with pronotal keel, extending to lower corner; stripe on dorsal margin of pronotum and along posterior margin; pair of long, submedian stripes on mesoscutum and spot, or very short stripe, next to tegula; transverse anterior stripe on scutellum; anterior half of metanotum; large spot on upper mesepisternum; short longitudinal bar at side of propodeum and narrow submedian stripes; narrow stripe along distal margins of terga 1-5, that of second extended forward along lateral margin nearly to base; most of sixth tergum; broad stripes along distal margins of sterna 2-5, slightly constricted sublaterally; entire sixth sternum; apices of all femora; broad outer stripe on pro- and mesotibiae; basal one-third of metatibia; tarsi. Wings yellowish, veins and stigma light reddish brown.

Type material.—Holotype and 11 paratype ♀: Cockburn Town, San Salvador, EL SALVADOR, no date (P. Bartsch). Holotype and 8 paratypes in USNM, 3 paratypes in LACM.

Etymology.—This species is named in memory of the late Joseph C. Bequaert, in recognition of his many outstanding contributions to the systematics of the Vespoidea.

Discussion.—Variation among the paratypes is not very great. Head width, as an indicator of size, varies from 3.64 to 4.10 mm. The mesoscutal stripe adjacent to the tegula, is always present and is usually broad and complete, but in two specimens it is narrow and briefly interrupted. The lateral stripes of the propodeum may be short and separated from the submedian stripes by about their own width, or long and broadly connected to the submedian stripes along their distal one-half (approximately).

The morphological distinctions between this species and *P. exclamans* are slight, but consistent. In *P. exclamans* the pronotal ridge is very slightly, or not at all, depressed mesad of the humeral angle, and often not depressed below it (Fig. 4). In that species, too, the first tergum is a little stouter, about 1.0-1.1 times longer than wide, and in profile is more convex and weakly, if at all, depressed in the apical one-third (Fig. 3). The first abdominal tergum of *P. bequaertellus* is a little more slender (1.15-1.28 times longer than wide, $\bar{x} = 1.20$). In *P. exclamans* the thorax is more abundantly marked with yellow and the distal stripes of the abdominal terga are broader and sublaterally constricted.

Superficially, *P. bequaertellus* resembles *P. cubensis* Lapeletier, but that species has conspicuous short hairs on the eyes, lacking in *P. bequaertellus*. The common Central American species, *P. instabilis* Saussure, is also similar but is extensively black on the thorax and abdominal venter, lacks mesoscutal stripes and is generally less richly marked (though with four propodeal stripes).

Subgenus *Epicnemius* Richards*Polistes pacificus* FABRICIUS

Polistes pacificus Fabricius, 1804:274.

Polistes liliaciosus Saussure, 1854:97, pl. 11. fig. 7. ♀. **New synonymy.**

Polistes liliaceusculus Saussure, 1854:98. ♀. **New synonymy.**

Polistes modestus F. Smith, 1862:38. ♀. **New synonymy.**

Polistes pacificus var. *flavopictus* Ducke, 1918:360, 374. ♀. **New synonymy.**

Polistes pacificus var. *trinitatis* Bequaert, 1937:195, 197. ♀. **New synonymy.**

Richards (1978) treated all of the above synonymous forms as subspecies of *P. pacificus*, a species which ranges from southern Texas to Argentina and Paraguay. These are all based on varying color combinations of black, ferruginous and yellowish markings. The darkest form with reduced yellow and ferruginous markings is *P. p. modestus* in the north. The southern form, in Brazil, Paraguay and Bolivia, is *P. p. liliaciosus*, with abundant yellow markings, including broad mesonotal stripes.

Each of these forms appears distinctive when isolated examples are seen. It is also true that when several hundred specimens from throughout the range of the species are available, there is a continuous cline of color variation. Richards noted the difficulty of dealing with this complex of overlapping forms, but opined that "several . . . will ultimately turn out to be species . . ." I do not agree with this prediction; too much obvious intergradation is present in the samples I have seen for this prediction to hold up. Nor do I see any utility in recognizing a series of subspecies based on selected populations in a highly variable species.

Polistes boharti Snelling, NEW SPECIES

(Figs. 5–7)

Diagnosis.—Related to *P. pacificus*, to which it will run in Richards' key. Male differs in having clypeus yellow, with apex acute, and digitus of genitalia with only a few straight setae. Female differs in having apex of clypeus acute, genal ridge complete to base of mandible; greatest width of gena equal to greatest width of eye, in profile.

Description male holotype.—Measurements (mm): Head width 3.74; head length 3.59; wing length 13.5; body length (head + thorax + extended abdomen) 19.5.

Head (Fig. 6): Slightly broader than long in frontal view, posterior ocelli anterior to slightly convex occipital margin; least length of malar area subequal to minimum antennal socket diameter. Clypeal breadth (between inner orbits) and length subequal; clypeus contiguous with eye margin for distance equal to maximum antennal socket diameter; apex of middle lobe acute, margins nearly straight; lateral sinus deep. Interocellar distance about 1.3 times diameter of anterior ocellus; ocellocular distance about 2.1 times diameter of anterior ocellus; ocelloccipital distance about 3.0 times diameter of anterior ocellus. Antennal segment 13, in profile, hardly curved in ventral view, about 1.4 times longer than broad. Gena, in profile, widest at about midlength, about equal to profile width of eye; genal ridge distinct, somewhat sinuate, continuous to base of mandible, though weak below sinuation.

Thorax: Pronotal keel well developed, narrowly lamellate, abruptly rounded onto side, blunt below on side; fovea well developed. Epicnemial groove strong;

dorsal groove of mesepisternum absent; entrance to spiracular chamber slightly raised, about half as wide as subalar plate. Groove between metepisternum and propodeum very weak, median furrow of propodeum broad, with fine, well spaced, transverse striae in middle which do not extend onto side except below; muscle-slit with sides converging above, apex narrowly rounded.

Abdomen: First tergum, in dorsal view, about as broad as long, spiracle prominent; in profile, sloping up steeply behind insertion of muscle (Fig. 5). Last ventral segment broad, apex rounded, disc depressed.

Terminalia: Digitus with only a few straight setae.

Sculpture: Clypeus dull, distal one-fourth closely micropunctate, remainder of disc contiguously micropunctate; head and thorax generally dull, contiguously minutely granulopunctate.

Color: Black. The following ferruginous: mandible; lateral lobes of clypeus; antenna (last 6 segments darker above); most of legs (except coxae, trochanters and dorsal portions of femora); irregular blotch on each side of second tergite. The following yellow: minute mandibular spot; clypeus mostly; inner orbital stripe, well into ocular sinus; outer orbital stripe (somewhat reddened); pronotal collar and dorsal margin and stripe down side almost to lower corner and spot at lower corner; margin of tegula; very narrow, evanescent stripe along anterior margin of scutellum; distinct stripe along anterior margin of metanotum; small spot on upper mesepisternum; broad submedian propodeal stripes; propodeal valve; antero-dorsal stripe and ventral blotch on mesocoxa; anterodorsal stripe on metacoxa; apical fasciae on first three terga, somewhat broadened laterally on first and second; narrow apical fascia on second sternum, weak across middle. Wings yellowish, slightly clouded; veins and stigma yellowish brown.

Female allotype.—Measurements (mm): Head width 3.64; head length 3.33; wing length 11.5; total length 15.0 (paratypes: head width 3.69–4.10; head length 3.33–3.79; wing length 11.5–13.5; total length 15.0–17.0).

Head (Fig. 7): Slightly broader than long in frontal view; ocelli, in frontal view, well anterior to nearly straight occipital margin; minimum length of malar area distinctly greater than minimum antennal socket diameter. Clypeal breadth slightly greater than length; clypeus contiguous with eye for distance about equal to minimum antennal socket diameter; apex of middle lobe acute, margins nearly straight, lateral sinus deep. Interocellar distance about 1.6 times diameter of anterior ocellus; ocellocular distance about 2.5 times diameter of anterior ocellus; ocelloccipital distance about 3.4 times diameter of anterior ocellus. Genal profile widest at about midlength and equal to greatest width of eye in profile; genal ridge distinct to base of mandible, weaker below, slightly sinuate.

Remainder about as in male, except usual sexual differences. Lower gena and malar area tessellate and moderately shiny, with sparse, conspicuous, moderate punctures (about 0.04 mm diameter).

Color: Black. The following ferruginous: mandible; most of malar area, transverse clypeal band; antenna (last six segments infuscated above); pale stripe on upper two-thirds of outer orbit; femoral apices; tibiae; tarsi. The following yellow: most of clypeus; irregular blotch on malar area adjacent to eye; inner orbital stripe, extending into ocular sinus; pronotal collar and dorsal margin and stripe down side to below level of fovea; side of axilla; anterior transverse stripe on scutellum and metanotum; spot on subalar plate; tegula; spot on upper mesepisternum; pair

of submedian propodeal stripes; propodeal valve; anterodorsal stripe on meso- and metacoxae; broad apical stripes on first three terga, sublaterally constricted on second and third segments, moderately expanded at side; medial one-half of margin of fourth tergum; very narrow margin of second sternum, greatly expanded at side. Wings as in male.

Type material.—All from MEXICO: Holotype male: Compostela, Nayarit, 26 Aug. 1959 (A. S. Menke and L. A. Stange). Allotype female: 3.9 km NE Taxco, elev. 1707 m, Guerrero, 16 Sept. 1976 (C. D. George and R. R. Snelling). Paratypes: 1 ♀, 64 mi W. Tehuantepec, Oaxaca, 21 July 1952 (E. E. Gilbert and C. D. MacNeil); 1 ♀, Terra Blanca, Vera Cruz, 15 Aug. 1962 (H. E. Milliron); 1 ♀, Santa Lucia, elev. 4000 ft, Sinaloa, 4 Aug. 1964 (W. R. M. Mason). Holotype and allotype in LACM; paratypes in CNC and UCB.

Etymology.—This species is dedicated to R. M. Bohart, colleague and early inspiration to my own work in vespoids.

Discussion.—Richards (1978) tentatively recorded under *P. pacificus* a female from Vulkan, Colima, MEXICO, which he thought might represent a different species; evidently this specimen is *P. boharti*.

The paratype females are somewhat variable in the extent of the ferruginous markings. In one (Tehuantepec), the clypeal stripe is broad and the outer orbital stripe is connected to the expanded blotch of the malar area; the yellow malar blotch is reduced to a narrow stripe along the lower orbit of the eye. There is a very obscure, reddish blotch on each side of the second tergum. The two remaining paratypes have only minute, ferruginous spots on the clypeal disc; both have distinct, ferruginous blotches on the second tergum.

Although this species is obviously close to *P. pacificus* the differences noted above should easily separate the two. The characteristic setation of the male digitus of *P. boharti* is especially distinctive. Although the male genitalic structures of the two species are very similar, the digitus of *P. pacificus* males bears many dark, stout, distally curved or hooked setae.

Females of the two species are similar. In females of *P. pacificus* the genal ridge is usually weak below, often not reaching much below the level of the lower one-fifth to one-fourth of the eye; if it extends below this level, it is very weak and rarely attains the base of the mandible. In *P. boharti* the ridge is as strong at the mandibular base as elsewhere. The gena, in profile, is narrower than the greatest eye width in *P. pacificus*, greater in *P. boharti*. The lower (lateral) extension of the pronotal ridge is not depressed in *P. pacificus* and a lobate humeral angle is not defined; in *P. boharti* the pronotal ridge is definitely depressed below the humeral angle and the latter is thus lobate.

Polistes palmarum Bequaert

Polistes major var. *palmarum* Bequaert, 1936:11. ♀.

Polistes major subsp. *slevini* R. Bohart, 1949:103. ♀. **New synonymy.**

This wasp is completely allopatric to *P. major* Beauvois, of which it has been considered a subspecies. The color pattern is remarkably stable and different from that of *P. major* and *P. palmarum* is therefore considered to be a separate species. The range of *P. palmarum* extends from canyons along the western margin of the Colorado Desert in California to the Cape Region of Lower California. Specimens

from the Cape Region were described as a separate subspecies, *P. major slevini*, by Bohart (1949). This form, with somewhat darker red integument than in more northern samples, is a minor variant of *P. palmarum*.

Genus *Clypearia* Saussure

***Clypearia naumanni* Richards**

Clypearia naumanni Richards, 1978:197-198. ♀.

Richards (1978) described this species from a single female from Barro Colorado Island, Canal Zone, PANAMA. The following specimens extend the range to the north: 1 ♀, Hacienda Comelco, 24 km NW Cañas, Guanacaste Province, COSTA RICA, 13 Jan. 1972 (E. R. Heithaus; LACM); 1 ♀, Los Mangos, Los Tuxtlas, Vera Cruz, MEXICO, 11 Sept. 1973 (M. Sousa; LACM).

Genus *Mischocyttarus* Saussure

Subgenus *Kappa* Bequaert

***Mischocyttarus atrocyaneus* Zikán**

Mischocyttarus atrocyaneus Zikán, 1949:204. ♀.

Mischocyttarus (Kappa) atrocyaneus: Richards, 1978:297. ♀.

Previously known only from PANAMA (BoQUITOS, Volcan de Chiriqui), COSTA RICA (San José) and MEXICO (Yucatán, no further data). New distribution data: Fortin de las Flores Vera Cruz, MEXICO; 2.5 mi W Quezaltepeque, EL SALVADOR; 9 km NW Gamboa, Canal Zone, PANAMA. The short series from near Gamboa is associated with two nests. One of these is small (12 cells), with a centrally placed pedicel; a single wasp was on the nest. The second nest, oblong, with the pedicel at one end, consists of 74 cells (many barely begun) and had seven or eight wasps when collected. Both nests were suspended under leaves.

***Mischocyttarus immarginatus* Richards**

Mischocyttarus immarginatus Richards, 1940:182. ♀.

Mischocyttarus oaxacanus Zikán, 1949:168-169. ♀, ♂. **New synonymy.**

Mischocyttarus immarginatoides Zikán, 1949:236. ♀ (*nomen nudum*).

Zikán (1949) described *M. oaxacanus* from a few specimens from several localities in MEXICO (Nuevo León and Oaxaca). Richards (1978) omitted mention of *M. oaxacanus* in his treatment of this genus. Dr. Richards informed me (*in litt.*) that he failed to find specimens that agreed with Zikán's description either in Paris or in Zikán's collection. The description and figures of *M. oaxacanus* agree, however, with specimens of *M. immarginatus* and I think it safe to assume them conspecific; *M. immarginatus*, described in 1940, has priority over *M. oaxacanus* (**New synonymy**).

Richards (1978) recorded *M. immarginatus* from MEXICO (Guerrero, Nayarit, San Luis Potosí, Vera Cruz and Yucatán), NICARAGUA and COSTA RICA. I have seen specimens from MEXICO (Guerrero, Jalisco, Nayarit, Oaxaca, Sinaloa and Yucatán), GUATEMALA (El Rancho), HONDURAS (Tegucigalpa), NICARAGUA (Managua; San Juan del Sur) and COSTA RICA (Hacienda Comelco and Nicoya, Guanacaste Province).

Mischocyttarus tolensis Richards

Mischocyttarus tolensis Richards, 1941:128. ♀.

This species was known from a few specimens from PANAMA, (Tolé; Barro Colorado Island; Alajuela). I have seen the following additional material: 1 ♂, 9 km NW Gamboa, Canal Zone, PANAMA, 4–8 Aug. 1975 (E. M. and J. L. Fisher; LACM); 4 ♀, Puerto Viejo, Heredia Province, COSTA RICA, 6 Aug. 1965 (R. J. Hamton; LACM).

The male of *M. tolensis* is unknown and the male collected near Gamboa is only provisionally assigned to *M. tolensis*. In the key to males of *Kappa* by Richards (1978), it runs to couplet 7 where it fails to agree with either alternative. The last antennal segment is about 2.5 times longer than wide and is distinctly shorter than the third flagellar segment; the occiput is sharply margined; the propodeal furrow bears abundant fine punctures and sparse coarser punctures; the propodeal valves are black; the clypeus and mandibles are largely ferruginous. Except for the flagellar characters and usual sexual differences, the male is very similar to females of *M. tolensis*, but lacks erect hairs on the eyes.

Subgenus *Monocyttarus* Richards*Mischocyttarus flavitarsis* (Saussure)

Polybia flavitarsis Saussure, 1854:199. ♀.

Mischocyttarus flavitarsis var. *centralis* Bequaert, 1933:129. ♀. **New synonymy.**

Mischocyttarus flavitarsis var. *idahoensis* Bequaert, 1933:133. ♀. **New synonymy.**

Mischocyttarus flavitarsis var. *kaibabensis* Bequaert, 1933:133. ♀. **New synonymy.**

Mischocyttarus flavitarsoides Zikán, 1949:236 (*nomen nudum*).

The range of *M. flavitarsis* extends from the Pacific Coast to the Rocky Mountains, from British Columbia and Alberta to northern Mexico. Throughout this range there exist a number of color phases which have been treated as subspecies: *M. f. centralis* Bequaert, *M. f. idahoensis* Bequaert, *M. f. kaibabensis* Bequaert, and *M. f. navajo* Bequaert, in addition to the nominate form. These various forms are based on differing combinations of the basic black and yellow color pattern, including replacement of black by ferruginous.

The northern, melanic, form is *M. f. idahoensis*, which is black, with greatly reduced yellow markings. The xanthic, southern, form is *M. f. kaibabensis*, in which the black color is completely replaced by ferruginous. Complete replacement of black by ferruginous also occurs in some populations of *M. f. centralis* from northern México, but the wings are yellowish rather than brown as in *M. f. kaibabensis*.

While the various color phases, in their ideal phenotypes, are distinct from one another, it is also true that considerable intergradation takes place in areas between such populations. In general, the variation is clinal and one form gradually replaces another. This is especially true of the series *M. f. idahoensis* → *M. f. flavitarsis* → *M. f. centralis* → *M. f. kaibabensis*. These forms do not, in my opinion, merit formal recognition. Each represents a selected point in a long clinal series. Therefore, *M. f. centralis* = *M. f. idahoensis* = *M. f. kaibabensis* = *M. flavitarsis*.

One form, *M. f. navajo*, seems to be much more stable, perhaps due to its relatively isolated distribution in central and southern Arizona. I have not yet

seen any material which I can consider to be intermediate between *M. f. navajo* and any other of the color phases attributed to *M. flavitarsis*. Therefore, I am inclined to believe that *M. navajo* should be elevated to species level until evidence is advanced to the contrary.

***Mischocyttarus navajo* Bequaert**

Mischocyttarus flavitarsis var. *navajo* Bequaert, 1933:133. ♀.

This wasp is found in Arizona, southwestern New Mexico and northern Sonora. It is common and quite stable in its color pattern. The wings are dark fuscous and the thorax is principally blackish, with limited yellow markings on the pronotum, spot below tegula and a pair of submedian propodeal stripes; the first tergum is black, with a broad apical yellow band. Richards (1978) remarked that this is "rather larger than subsp. *flavitarsis*." I have measured head width of 50 randomly selected females of *M. flavitarsis* and 50 of *M. navajo*, no two individuals with the same collection data.

The results confirm Richard's assumption. For *M. flavitarsis* the head width range is 3.08–3.95 mm, with the mean at 3.52 mm; only 24% of the specimens measured had a head width in excess of 3.75 mm. Head width, in the measured specimens of *M. navajo* ranged between 3.18 and 4.21 mm, with a mean width of 3.75 mm; 62% of the measured specimens have a head width of 3.75 mm or more.

Subgenus *Monacanthocnemis* Ducke

***Mischocyttarus chalucas* Snelling, NEW SPECIES**

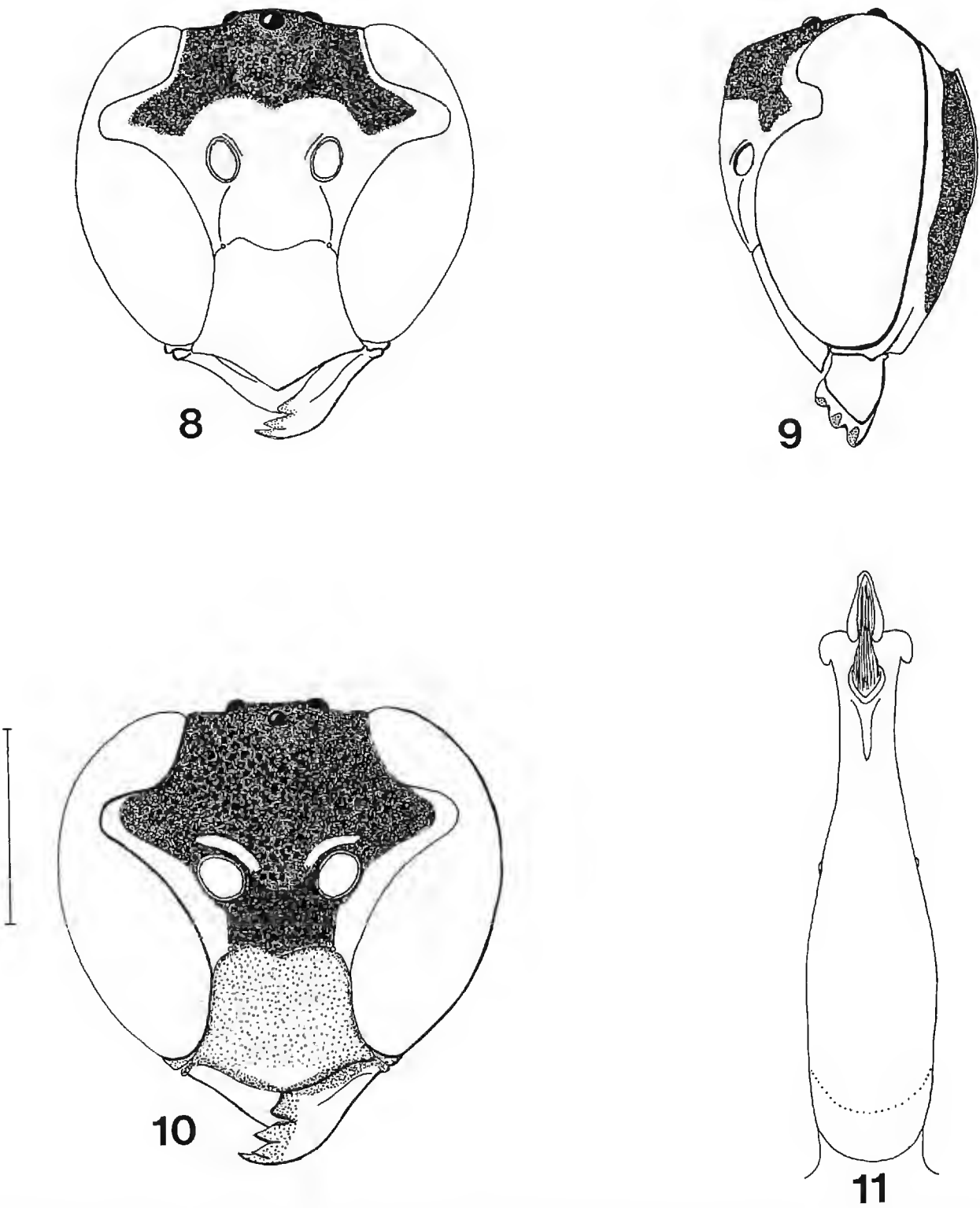
(Figs. 8–11)

Diagnosis.—First tergum slender, anterior width less than distal width of metafemur; dorsal mesepisternal groove distinct; mesoscutum closely to densely coarsely punctate, interspaces with abundant very fine punctures; last antennal segment of male weakly curved, about 2.5 times longer than broad at base; and fifth to seventh flagellar segments a little broader than long.

Description female holotype.—Measurements (mm): Head width 2.32; head length 1.65; wing length 7.5; total length 11.5.

Head (Fig. 10): About 1.4 times broader than long; ocelli at top of flat vertex. Malar space very narrow, eye nearly touching base of mandible. Clypeus narrow, about 1.2 times longer than wide, contiguous with eye for distance about twice minimum antennal socket diameter; apical margin obtuse. Interantennal distance about twice minimum antennal socket diameter; minimum antennal socket diameter about 1.5 times antennoocular distance and slightly greater than antenno-clypeal distance. Flagellum stout, first segment about 0.8 times length of scape and longer than combined second and third segments. Frons very slightly bulging and very weakly depressed in middle. Interocellar distance about 1.6 times anterior ocellus diameter; ocellocular distance subequal to anterior ocellus diameter. Gena about one-half as wide as eye profile at sinus.

Thorax: Slender, about 1.5 times longer than wide. Pronotal keel, in dorsal view, concave, strongly lamelliform laterad, weak in middle, strongly lobate and somewhat reflected at humerus. Proepisternum bi-reflexed in front. Propodeal furrow broad, weak, without median ridge; valves narrow. Mesotibia with two



Figs. 8–11. *Mischocyttarus chalucas*. 8, ♂ head, frontal view; 9, ♂ head, lateral view; 10, ♀ head, frontal view; 11, petiole dorsal view. Scale line = 1.0 mm.

apical spurs. Inner, distal margin of last two metatarsal segments not produced, outer margin strongly produced.

Gaster: Petiole slender, about 3.5 times longer than greatest width, when measured from propodeal insertion (Fig. 11); spiracle at about midlength and short of apex of metacoxa.

Sculpture: Clypeus and supraclypeal area dull, subcontiguously to densely micropunctate and with dense to close, moderate punctures; gena dull, closely micropunctate and with sparse, somewhat coarser punctures; occiput shiny, with irregularly spaced moderate punctures and a few micropunctures; remainder of head and thorax shiny, with dense to close, moderate punctures, interspaces closely micropunctate.

Color: Black, but irregularly replaced with ferruginous on head (especially clypeus and gula) and thorax (especially below and on side). Following pale yellow: broad stripe along dorsal mandibular margin; transverse bar at apex of clypeus; inner orbital line to top of sinus; curved bar above each antennal socket; outer orbital line nearly to top of eye; keel, most of dorsal margin and lower corner of pronotum; subalar and lower posterior spot on mesepisternum; broad anterior stripe on scutellum; anterior stripe, narrowed in middle, and lateral extensions of metanotum; large, submedian, posterior spots on propodeum; valves; narrow distal fascia on first five terga and second to fifth sterna, that of second tergum extended along side nearly to base; short lateral stripe on sixth tergum and sternum; short apicoventral stripe on procoxa; outer stripe on mesocoxa; two dorsal stripes on metacoxa; small apicodorsal spot on each femur; outer stripe on protibia; basal spot, long median stripe and small apical spot on mesotibia; short stripe on outer face of probasitarsus and on outer face of prodistitarsus. Tibial spurs dirty white. Wings clear, slightly infuscated; veins and stigma brown.

Male allotype.—Measurements (mm): Head width 2.10; head length 1.77; wing length 7.0; total length 11.0.

Similar to female, except usual sexual differences, and the following.

Head (Fig. 8): About 1.2 times wider than long. Mandible tridentate. Antennoclypeal distance a little greater than minimum antennal socket diameter; minimum antennal socket diameter about twice antennocular distance. Frons bifaced, i.e., there is a more or less vertical anterior portion and a definite dorsal face forming a flat plane in front of anterior ocellus (Fig. 9). Scape stout-pyriform, about 1.6 times longer than broad, apical width about 1.6 times basal width; first flagellar segment flattened, about 1.8 times longer than broad, about twice longer than second; fifth to seventh segments broader than long; eighth as broad as long and narrower than seventh; ninth and tenth a little longer than broad; apical segment about 2.5 times longer than wide at base, slightly curved in profile.

Color: Very similar to that of female, but underside of scape, ventral surface of thorax and coxae yellow.

Type material.—Holotype female and allotype: Tuxtla Gutierrez, Chiapas, MEXICO, 7 June 1964 (J. D. and D. Pallister) in AMNH.

Etymology.—Chalucas, for whom this species is named, is a trickster god and folk hero of the Zoque Indians indigenous to the Tuxtla Gutierrez region.

Discussion.—This species appears to be most similar to the South American *M. punctatus* (Ducke). The petiolar spiracle, however, is anterior to the end of the metacoxa (slightly beyond in *M. punctatus*), the dorsal mesepisternal groove is stronger, and the mesoscutal punctures are clearly a mixture of moderate (0.04–0.06 mm diameter) and very fine (less than 0.01 mm diameter) punctures. In *M. punctatus*, the finest punctures are about 0.02 mm diameter and grade up to the punctures of moderate size (about 0.05 mm diameter) and the punctures, irrespective of size, are very evenly spaced, while the moderate punctures of *M. chalucas* are irregularly spaced from subcontiguous to interspaces of more than a puncture diameter.

ACKNOWLEDGMENTS

For making available material utilized in this study, I wish to thank: P. H. Arnaud, Jr., California Academy of Sciences (CAS); M. Favreau and J. G. Rozen,

Jr., American Museum of Natural History (AMNH); L. Masner, Canadian National Collections (CNC); A. S. Menke, National Museum of Natural History (USNM); J. A. Powell, University of California, Berkeley (UCB). Other specimens were from the collections of the Natural History Museum of Los Angeles County (LACM).

LITERATURE CITED

- Bequaert, J. C. 1933. The nearctic social wasps of the subfamily Polybiinae (Hymenoptera, Vespidae). *Ent. Amer. (n.s.)* 13:87-150.
- . 1936. Two new color forms of *Polistes major* Palisot de Beauvois from California and Arizona (Hymenoptera, Vespidae). *Ent. News* 47:7-13.
- . 1937. The American *Polistes* with prepectal suture. Their structural characters, distribution and variation. *Archiv. Inst. Biol. Vegetal.* 3:171-205.
- Bohart, R. M. 1949. Notes on North American *Polistes* with descriptions of new species and subspecies (Hymenoptera: Vespidae). *Pan-Pac. Ent.* 15:97-103.
- Drury, D. 1770. Illustrations of natural history. London. Vol. 1, xxviii + 130 pp.
- Ducke, A. 1918. Catalogo das Vespas do Brasil. *Rev. Mus. Paulista* 10:314-374.
- Fabricius, J. C. F. 1804. *Systema Piezatorum*. Hafniae, 572 pp.
- Lepeletier de St. Fargeau, A. L. M. 1836. Histoire naturelle des insectes. Hyménoptères. I. Roret's Suites à Buffon, Paris.
- Réamur, R. A. F. de. 1742. Mémoires pour servir a l'histoire des insectes, 6. Paris, 608 pp.
- Richards, O. W. 1940. Preliminary diagnoses of some new species of *Mischocyttarus* Saussure (Hymenopt., Vespidae). *Ann. Mag. Nat. Hist. (11)* 5:176-183.
- . 1978. The social wasps of the Americas, excluding the Vespinae. Publ. 786, Brit. Mus. (Nat. Hist.), London, 580 pp.
- Saussure, H. de. 1854. Etudes sur la Famille des Vespides 2. Monographie des guêpes sociales on de la tribu des Vespiniens. Paris and Geneva, pp. 97-256.
- Smith, F. 1862. Description of new species of Hymenoptera collected at Panama by R. W. Sketch, with a list of described species. *Trans. Ent. Soc. London* (3) 1:29-44.
- Snelling, R. R. 1954. Wasps of the genus *Polistes* in California and Arizona (Hymenoptera: Vespidae). *J. Kansas Ent. Soc.* 27:151-155.
- . 1955. Notes on some *Polistes* in the American Museum of Natural History, with descriptions of New North American subspecies (Hymenoptera, Vespidae). *Amer. Mus. Novit.* 1701, 9 pp.
- . 1970. The social wasps of Lower California, Mexico (Hymenoptera: Vespidae). *L. A. Co. Mus. Contr. Sci.* 197, 20 pp.
- Vallot, J. N. 1802. Concordance systématique, servant de table des matières à l'ouvrage de Réamur intitulé Mémoires, Paris, 198 pp.
- Zikán, J. F. 1949. O Gênero *Mischocyttarus* Saussure (Hymenoptera, Vespidae), com a descrição de 82 especies novas. *Bol. Parq. Nac. Itatiaia* 1:1-251.

**A Synopsis of the Genus *Epanthidium* Moure with the
Description of a New Species from Northeastern
Mexico (Hymenoptera: Megachilidae)¹**

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The genus *Epanthidium* consists of 12 described species from southern South America. Therefore, it was surprising to discover a 13th species from northeastern Mexico. Although amphitropical distribution is relatively uncommon in bees, it is not unknown even in the Anthidiini. For example, Michener and Ordway (1964) described a species of the anthidiine bee genus *Nananthidium* Moure from northeastern Mexico. This genus was previously known only from southern South America.

I have not seen all of the primary types (those seen are identified by an exclamation point after the depository) and for some species interpretations I have relied on the original descriptions and specimens identified by Schrottky, Friese and Moure. However, it must be pointed out that the original descriptions are based largely on color, which is often variable within species and also similar in different species, so that a few nomenclatorial corrections may be anticipated. I hope to treat the generic relationships of the New World genera of Anthidiini at a future date since data gathered after Michener's 1948 revision of the tribe suggest some different groupings.

I present here a key to the known species which should aid in future type and revisionary studies, and also to suggest the relationship of the new species described here. New records and floral associations gathered to date are also provided.

ACKNOWLEDGMENTS

I would like to acknowledge the valuable assistance of Padre Jesus Moure in species identification. Jack Neff has provided many new floral records. Special thanks are due also to Charles Porter, Manfredo Fritz, and George and Richard Bohart for many valuable specimens. Other important collaborators are acknowledged in the list of collections consulted. Field work in South America was supported by the National Geographic Society (1977) and the Consejo Nacional de Investigaciones Científicas y Técnicas (1976), Buenos Aires, Argentina.

COLLECTIONS STUDIED AND TYPE DEPOSITORIES

AMNH—American Museum of Natural History, New York 10024. J. G. Rozen, Jr.

¹ Contribution No. 549. Bureau of Entomology, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, Florida.

- Berlin—Zoologisches Museum der Humboldt—Universität, East Berlin, Germany.
- BM—British Museum (Natural History), London, England. I. H. H. Yarrow.
- Curitiba—Department of Zoology, University of Paraná, Curitiba, Brasil. J. Moure.
- FSCA—Florida State Collection of Arthropods (Hymenoptera Collection), Gainesville, Florida 32602. H. V. Weems, Jr.
- Fritz Collection—Private collection. Instituto Entomológico de Salta, P.O. Box 3, Rosario de Lerma, Salta, Argentina. Manfredo Fritz.
- IML—Instituto Miguel Lillo, San Miguel de Tucumán, Argentina. A. Willink.
- KU—Snow Entomological Collection, University of Kansas, Lawrence, Kansas 66045. C. D. Michener.
- Logan—Bee Biology & Systematics Laboratory, Utah State University, Logan, Utah 94321. G. E. Bohart.
- LACM—Natural History Museum of Los Angeles County, Los Angeles, California 90007. R. R. Snelling.
- MLP—Museo de Ciencias Naturales, La Plata, Argentina. L. de Santis.
- Paris—Musée National d'Histoire Naturelle, Paris, France. S. Kellner-Pillault.
- Porter Collection—Private collection. 301 N. 39th Street, McAllen, Texas 78501.
- São Paulo—Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brasil.
- UCD—Entomology Museum, University of California, Davis, California 95616. R. M. Bohart.
- USNM—U.S. National Museum of Natural History, Washington, D.C. 20560. A. S. Menke.
- Vienna—Naturhistorisches Museum, Vienna, Austria. M. Fischer.

***Epanthidium* Moure, 1947**

Type species: *Hypanthidium tigrinum* Schrottky, by original designation.

This genus was reduced to subgeneric status (under *Dianthidium*) by Michener (1948), but its structural characters warrant generic status in my opinion. These include the absence of the preoccipital carina, male hindcoxa not spined, presence of upper propodeal pits at least laterally, modified metasomal sternum VI of the female and sternum II of the male, and the elevated lamella of the posterior lobe of the pronotum. Although little information on nesting habits is available, one nest I examined was made from adobe clay (5 cells), and no resin was used, which contrasts with the better known nests of *Dianthidium* (Grigarick and Stange, 1968) which have plant resins as the common bonding material. *Anthidium inerme* Friese, 1908, was included in the genus by Michener (1948) but my studies of the type material have convinced me that it is not congeneric and probably belongs to a new genus.

Diagnosis.—Body robust, mesoscutum broader than long; interalveolar carina absent; female mandible 4-toothed; maxillary palpus 2-segmented; preoccipital carina absent; arolium present; pronotal lobe lamellate, elevated, sometimes low and opaque; anterior and lateral faces of mesepisternum separated by a carina; propodeum with sulcus behind spiracle; row of pits along upper margin of propodeum strongly developed at least laterally; posterior coxa of male without spine (although a small tooth present in a few species); metasomal sternum VII of male

trilobed or bilobed; sternum II with a transverse elevation usually ending sublaterally in a spine; female sternum VI variously modified with processes or ridges.

Epanthidium boharti Stange, NEW SPECIES
(Figs. 1, 8, 11)

Diagnosis.—The bilobate metasomal tergum VII of the male (Fig. 1) is distinctive in the genus (other species are trilobate) except for *E. paraguayense* (Schrottky) from South America. These 2 species can be separated in the male by the deeper emargination of tergum VII in *E. boharti*. Female *E. boharti* can be distinguished from all other known species except *E. paraguayense* and *E. erythrocephalum* by the lack of a median carina on metasomal tergum VI. From these 2 species, female *E. boharti* can be distinguished by the sublateral tooth on sternum VI (from *erythrocephalum*) and the distance between the lateral ocellus and the posterior margin (from *paraguayense*). The black and ivory coloration in both sexes of *E. boharti* is distinctive from the South American species which usually have red or orange markings.

Holotype male.—Length 14 mm, forewing 10 mm; width of metasoma (at middle) 5 mm. Base color black with ivory markings as follows: clypeus except apex and dorsal margin to tentorial pit; paraocular stripe from clypeus to about level of antenna; small spot near dorsal margin of eye; anterior margin of mesoscutum interrupted widely at middle where it points posteriorly, and extending along lateral margin to near middle of tegula; axillae nearly completely; metanotum with large spot laterally interrupted medially by a triangular black area; metasomal tergum I with large sublateral spot extending nearly to middle, broadly emarginate posteriorly; following 3 terga with sublateral spots decreasing in size posteriorly; terga III-VI with transverse stripe at middle decreasing in length posteriorly; pubescence mostly whitish except for closing faces of tarsi which are golden color. Forewing uniformly dark infusate with violaceous reflection, except apical $\frac{1}{4}$.

Pubescence—Basitarsus of foreleg and midleg with many elongate setae on posterior margin, about 3 times as long as greatest width of tarsus.

Puncturation—Vertex posterior to ocelli shiny with setiferous punctures about one puncture apart. Tegula shagreened but nearly impunctate at middle; upper row of propodeal pits absent at middle; area anterad of sternum II ridge sparsely punctate.

Structure—Clypeal apex with 4 fairly evenly spaced teeth; scape shorter than pedicel and first 3 flagellomeres together; distance between lateral ocellus and hind margin greater than interocellar distance; height of posterior lobe of pronotum less than midocellus diameter, opaque; mesepisternum not produced ventrally into small tooth; midventral carina of mesosoma low throughout; tegula with posterior margin narrow, thin (as in Fig. 20); midcoxa without tooth at mesal posterior margin; curved ridge of sternum II strongly raised with strongly sloping posterior face, sublateral tooth moderately developed; tergum VII bilobate (Fig. 1); lateral margins of terga V-VI without teeth or tubercles; genitalia as in Fig. 8.

Female.—As described for male except as follows: clypeus black, vertex with posterior margin orange-colored; scopa whitish; foreleg and midleg without elongate setae on basitarsi; tegula densely punctured at middle; mandible quadri-

punctate; tergum VI without longitudinal carina and with subapical margin strongly angled laterally followed by undulating outline to sting emargination, without teeth; sternum VI with sublateral ridge produced into tooth sublaterally, medial process narrowly rounded (Fig. 11).

Types.—Holotype ♂: MEXICO, *Tamaulipas*: 55 km S. Ciudad Victoria, Ruta 85 ca. Llera, 22, 25-VI-1981, B. Miller, C. Porter, L. Stange (FSCA). Paratypes as follows: 2 ♀, same data as holotype (FSCA, Porter Collection). MEXICO: *Nuevo Leon*: Cola de Caballo, ca. El Cercado, 15-23-VI-1976, 2 ♀, C. Porter (FSCA, Porter Collection); *Tamaulipas*: Ruta 180, ca. Soto la Marina, 75 km E. Ciudad Victoria, 1-VII-1981, 1 ♀, B. Miller, C. Porter, L. Stange (FSCA).

Etymology.—This species is named for Richard M. Bohart in celebration of his seventieth year.

***Epanthidium anisitsi* (Schrottky)**

(Fig. 6)

Dianthidium anisitsi Schrottky, 1908:231. Syntypes, ♂, ♀, Asuncion, Paraguay, Anisits Collection (not located).

Anthidium olympinum Strand, 1910:546 (synonymy after Schrottky, 1920:211).

Three syntypes, ♂, Asuncion, Paraguay (Berlin).

Taxonomy: Moure, 1947:35 (in *Epanthidium*).

This is one of the largest species in the genus, with the spine of the curved ridge of the male sternum II unusually large and somewhat erect. Male tergum VII is distinctive in that the middle process is below the plane of the lateral process (Fig. 6). The female is unknown to me. I have not seen the types, but I have seen a specimen identified by Schrottky in 1910.

New record.—PARAGUAY: Cuagazu, XI-79, M. Fritz coll. (1 ♂—FSCA).

***Epanthidium autumnale* (Schrottky), NEW COMBINATION**

(Figs. 2, 9, 12)

Dianthidium autumnale Schrottky, 1909a:218. Holotype ♂, Paraguay, Puerto Ber-toni, 2-III-1909 (not located).

This species is, according to my records, commonest in arid northwestern Argentina. A few specimens seen from Brazil and Argentina (Misiones) have more extensive yellow bands on the metasomal terga. The male has a distinctive tergum VII with the emargination between the middle and lateral process very shallow (Fig. 2). The yellow spot on the male hindcoxa is distinctive except for *E. nigrescens* and *E. bicoloratum*.

New records (37 ♂, 24 ♀).—ARGENTINA: *Catamarca*: El Rodeo, IV, Porter (1 ♂, 1 ♀—FSCA); 20 km E. Belen, flowers of *Zuccagnia*, X, Stange (1 ♀—FSCA). *Salta*: Yacochuya, III–IV, Porter, Stange, Willink collectors (6 ♂, 17 ♀—IML, FSCA); Tacuñ, I, Stange, Willink collectors (1 ♀—FSCA); 5 km W. Agua Blanca, V, Stange (2 ♂—FSCA); Rio Pescado, IX, Porter (1 ♀—FSCA). *Tucuman*: San Pedro de Colalao, XI, Stange (2 ♂—FSCA); Tacanas, XI, XII, Stange (2 ♂—FSCA); Raco, I, Stange (1 ♂, 1 ♀—FSCA); Amaicha del Valle, I, Stange (1 ♀—FSCA). *Jujuy*: 7 mi. S. Volcan, III, Stange (1 ♂—FSCA); Humahuaca, I, Stange (1 ♀—FSCA). *La Rioja*: Angulos, XII, Porter & Stange (1 ♂—FSCA). *Cordoba*: Los Cocos, I, Stange (1 ♂, 2 ♀—FSCA); Saltos Blancos, I, Stange (1 ♂—FSCA). *Misiones*:

Cataratas del Iguazu, XI, Porter & Stange (1 ♂, 2 ♀—FSCA). BOLIVIA: *Santa Cruz*: General Saavedra, VII, Porter & Stange (1 ♀—FSCA). BRAZIL: *Santa Catalina*: Nova Teutonia, XI, Plaumann (1 ♀—KU).

***Epanthidium bertonii* (Schrottky)**

(Figs. 5, 17)

Dianthidium bertonii Schrottky, 1905:3. Holotype ♀, Paraguay, Puerto Bertoni, Bertoni (not located).

Dianthidium brethesi Schrottky, 1909a:217. Holotype ♂, Catamarca, III-08, C. Bruch (not located). **New synonymy.**

Anthidium argentinum Friese, 1908:72. Syntypes, ♂, ♀, Tucuman and Mendoza, XI (not located). **New synonymy.**

Taxonomy: Schrottky, 1908:230 (description ♂); Moure, 1947:35 (in *Epanthidium*).

My identifications are based on studies at Curitiba in 1974 and on the literature. There are 2 color forms; dark populations (*brethesi*) exist in the Subandean desert of Argentina, and more reddish populations occur in more humid areas. This species has no unusual features which would provide easy diagnosis.

New records (11 ♂, ♀).—ARGENTINA: *Catamarca*: 3 km N. Belen, XII, Porter & Stange (3 ♂—FSCA); Andalgala, J. Neff (3 ♂, 2 ♀—FSCA). *Cordoba*: Sierras, XII, Williner (1 ♀—FSCA); *Formosa*: Riacho Negro, XI, Willink (3 ♀—IML, FSCA). *La Rioja*: Carrizal, G. Bohart, XI (1 ♂—FSCA); Famatina, XII, Porter & Stange (1 ♀—FSCA). *Misiones*: San Ignacio, XII, Willink (1 ♂—FSCA). *Salta*: San Carlos, I, Monroe & Willink (1 ♂—IML). *San Luis*: Villa Dolores, II, Porter (1 ♀—FSCA). *Tucuman*: San Pedro de Colalao, I, Stange (1 ♀—FSCA); Amaicha, XI, Stange (2 ♀—FSCA, IML). BOLIVIA: *Santa Cruz*: Rio Piray, VII, Porter & Stange (1 ♂—FSCA). PARAGUAY: Villarrica, I, Schade (1 ♂—FSCA).

***Epanthidium bicoloratum* (Smith)**

(Figs. 12, 19)

Anthidium bicoloratum Smith, 1879:88. Holotype ♀, Mendoza (BM!).

Anthidium bicoloratum tucumanum Vachal, 1904:14. Holotype ♀, Tucuman, coll. Vachal (Paris). **New synonymy.**

Taxonomy: Schrottky, 1908:230 (in *Dianthidium*, description of ♂); Friese, 1908:74 (description of ♂); Moure, 1947:35 (in *Epanthidium*).

This species is easily identified in both sexes by the tegula (Fig. 19) which is drawn out posteriorly, thickened and compressed laterally.

New records (29 ♂, 32 ♀).—ARGENTINA: *Catamarca*: Andalgala, flowers *Prosopis alba*, X, Stange & Willink (1 ♀—IML); Belen, X, Stange (2 ♂—FSCA). *Chaco*: San Bernardo, VI, Sorio (1 ♀—Fritz Coll.). *Cordoba*: Quebrada Honda, Unquillo, I, Stange (1 ♀—FSCA); Los Cocos, I, Stange (1 ♀—FSCA). *Corrientes*: Paso de la Patria, XI, Porter (1 ♂, 3 ♀—FSCA); Santa Ana, V, Porter & Stange (1 ♀—FSCA). *La Rioja*: Famatina, XII, Porter & Stange (1 ♀—FSCA); 7 mi. S. Villa Casana, XII, Porter & Stange (1 ♀—FSCA); Santa Cruz, X, Stange (1 ♂—FSCA); Villa Union, XII, Porter & Stange (1 ♀—FSCA). *Misiones*: Posadas, XI, Porter & Stange (1 ♂—FSCA). *San Juan*: Albardon, XII, Porter & Stange (1 ♀—FSCA). *San Luis*: San Jeronimo, II, Fritz (1 ♀—Fritz Coll.). *Salta*: Yacochuya, 9 km N.W. Cafayate,

IV, Porter & Stange (2 ♂, 2 ♀—FSCA). *Santiago del Estero*: Los Tigres, I, Golbach (1 ♂—FSCA); Las Termas del Rio Hondo, IV, Porter & Stange (1 ♀—FSCA). *Tucuman*: Amaicha, XI, Stange (1 ♂—FSCA); 11 km W. Las Cejas, X, I, Stange (1 ♂, 1 ♀—FSCA); Villa Padre Moure, IV, Stange (1 ♂—FSCA).

***Epanthidium confusum* (Smith)**

(Fig. 16)

Anthidium confusum Smith, 1879:80. Holotype ♂, Mendoza (BM!).

Anthidium dentiventre Friese, 1906:100. Holotype ♀, Mendoza (Friese Coll., Berlin). Preoccupied by *Anthidium dentiventris* Friese, 1904.

Anthidium jenseni Friese, 1908:69. New name for *A. dentiventre* Friese, 1906.

Taxonomy: Joergensen, 1912:137 (*jenseni* = *confusum*); Moure, 1947:35 (in *Epanthidium*).

This very distinctive species occurs in the *Larrea* Subandean desert of Argentina but also in N.E. Argentina. The abruptly raised midventral carina of the thorax is distinctive in both sexes, and the abruptly raised longitudinal carina of tergum VI is distinctive in the female. The tricolored abdomen, consisting of red anteriorly and dark posteriorly, marked with large transverse pale spots is also distinctive.

New records (8 ♂, 15 ♀).—ARGENTINA: *Catamarca*: Ampajango, XII, Stange (1 ♂, 1 ♀—FSCA); El Pucara, Neff (1 ♀—FSCA); Cuesta de la Chilca, XII, Neff (2 ♂—FSCA). *Cordoba*: Bialeto Masse, II, Willink (1 ♀—IML); Alta Gracia, XI, Stange (1 ♀—FSCA); Quilpo, II, Fritz (1 ♀—FSCA); Capilla del Monte, II, Fritz (2 ♀—Fritz Coll.). *Corrientes*: Ituzaingo, XII, Fritz (2 ♀—Fritz Coll., FSCA). *Entre Rios*: Liebig, II, Fritz (1 ♂—Fritz Coll.). *Mendoza*: Potrerillos, II, Stange (1 ♂—FSCA). *Salta*: Yacochuya, 9 mi. N.W. Cafayate, X, XII, Porter & Stange (1 ♂, 2 ♀—FSCA). *Tucuman*: Amaicha, XI, Stange (1 ♂—FSCA).

***Epanthidium erythrocephalum* (Schrottky)**

(Figs. 13, 21)

Anthidium erythrocephala Schrottky, 1903:453, Pl. XIII, Fig. 8. Syntypes, ♂, ♀, Campinas, São Paulo (São Paulo).

Taxonomy: Schrottky, 1910:271 (in *Dianthidium*); Moure, 1947:35 (in *Epanthidium*).

Both sexes are distinguished by the angled axilla (Fig. 21). The lack of a longitudinal carina on tergum VI of the female is shared only by *E. boharti* and *E. paraguayense*. Schrottky (1903) gave a color figure of this species which has distinctive coloration among the known Brazilian species.

New records (14 ♂, 9 ♀).—ARGENTINA: *Misiones*: Bompland, III, Joergensen (1 ♂—La Plata); Cataratas del Iguazu, XI, Porter & Stange (1 ♀—FSCA). *Salta*: Rio Pescado, YPF Estacion, XI, Porter (1 ♂—FSCA); Yacochuya, 9 km N.W. Cafayate, XII, IV, Porter & Stange (2 ♂, 1 ♀—FSCA). *San Juan*: Pocitos, I (1 ♂—FSCA). *Tucuman*: Horco Molle, 700 m, II, Stange (1 ♂—FSCA); Tacanas, XII, Stange (1 ♀—FSCA). BOLIVIA: *Santa Cruz*: Saavedra, Est. Experimental, I, Stange (1 ♀—FSCA); 38 km N. Santa Cruz, I, Stange (1 ♀—FSCA); Buena Vista, VII, Stange (2 ♂—FSCA). BRAZIL: *Goiás*: Aragarcas, I, Oliviera (1 ♀—FSCA). PARAGUAY: Rio Ypone, Cororo, II, Fritz (5 ♂, 4 ♀—FSCA, Fritz Coll.).

***Epanthidium joergenseni* (Friese)**

(Figs. 3, 15)

Anthidium joergenseni Friese, 1908:73. Syntypes, ♂, ♀, Mendoza (Pedregal) and Tucuman, Argentina (not located).

Dianthidium bruchi Schrottky, 1909a:217. Holotype ♂, Catamarca, Argentina, C. Bruch, III-08 (not located). **New synonymy.**

Taxonomy: Joergensen, 1912:137 (in *Dianthidium*); Moure, 1947:35 (in *Epanthidium*).

This is one of the largest species in the genus, apparently confined to the *Larrea* Subandean desert in Argentina. The female has a characteristic subapical ridge on sternum VI with a strongly developed lateral process much anterior to the large apical process (Fig. 15), the 3 processes forming an almost equilateral triangle. The male is less easily characterized but lacks reddish bristles on sternum II and III, has tergum VII with the emargination between the middle and lateral processes rather narrow (Fig. 3), and lacks specializations found in other species (axilla not modified, midventral carina of thorax not raised, tegula neither drawn out nor impunctate). I am synonymizing *Dianthidium bruchi* Schrottky based on the original description.

New records (10 ♂, 9 ♀).—ARGENTINA: *Catamarca*: Andalgala, X, I, flowers of *Verbecina*, Neff, Stange & Willink (4 ♂, 1 ♀—FSCA, IML); Ampajango, XII, Stange (1 ♀—FSCA); Los Nacimientos de Abajo, I, III, Stange & Willink (1 ♂, 1 ♀—FSCA, IML). *Salta*: Yacochuya, 9 km N.W. Cafayate, IX, Stange & Willink (1 ♂, 1 ♀—FSCA, IML); Tacuil, XII, Stange & Willink (1 ♂—IML). *Santiago del Estero*: Rio Salado, Wagner (1 ♀—La Plata). *Tucuman*: Amaicha, XI, Stange (3 ♂, 1 ♀—FSCA).

***Epanthidium nectarinioides* (Schrottky)**

(Fig. 22)

Anthidium nectarinioides Schrottky, 1903:451. Syntypes, ♂, ♀, Campinas, São Paulo, Brazil, 30-I (São Paulo).

Taxonomy: Schrottky, 1910:271 (in *Dianthidium*); Schwarz, 1933:21 (in *Anthodioctes*); Moure, 1947:35 (in *Epanthidium*).

This species is easily recognized by the color pattern. The black body with metasomal terga III–VI yellowish orange is unique in the genus. However, this pattern is common in *Anthodioctes* (Megachilidae) and *Brachygastra* (Vespidae) and other Hymenoptera of the same region. In the original description, this name is spelled “*nectarinioides*” but this is obviously a typographical error since the name is spelled “*nectarinioides*” in two other places (pp. 444, 445 in Keys). The spelling “*nectarinioides*” has been used in all subsequent citations.

New records (5 ♂, 4 ♀).—ARGENTINA: *Jujuy*: Camino St. Pedro, II, Monroe & Willink (1 ♂—IML). *Misiones*: I (1 ♂—La Plata). *Salta*: Pocitos, XI, IV, Porter & Fritz (2 ♂, 2 ♀—FSCA, Fritz Coll.); Rio Pescado, YPF Estacion, IV, Porter (1 ♂, 1 ♀—FSCA).

***Epanthidium nigrescens* Friese, NEW COMBINATION**

(Fig. 18)

Anthidium nigrescens Friese, 1906:100. Syntypes, ♂, ♀, Mendoza, Salta (AMNH!; Berlin).

The male is distinguished by the combination of reddish bristles mesad of sublateral tooth of transverse ridge of sternum II, densely punctate unmodified tegula and raised ventral median longitudinal carina of mesothorax. The lack of a definite sublateral spine-like process (Fig. 18) on female sternum VI is distinctive. Also, the weak longitudinal carina of tergum VI is a helpful character to identify the females. A nest was seen from Bolivia with 5 cells (no resin) in adobe clay attached beneath a rock overhang.

New records (41 ♂, 38 ♀).—ARGENTINA: *Jujuy*: Palpala, I, Aczel (2 ♂—IML); 6 km S. Volcan, III, Stange & Willink (1 ♀—FSCA). *Mendoza*: Mendoza, I (1 ♂—FSCA). *Salta*: Yacochuya, 9 km N.W. Cafayate, IV, Porter & Stange (32 ♂, 30 ♀—IML, FSCA, LACM); Tacuil, IV, Stange & Willink (2 ♂, 2 ♀—IML, FSCA). *Tucuman*: Amaicha, XI, I, Stange (3 ♂, 1 ♀—FSCA). BOLIVIA: Camargo, 2480 m, I, Weyrauch (2 ♂—IML, FSCA).

***Epanthidium paraguayense* (Schrottky)**

(Fig. 4)

Dianthidium paraguayense Schrottky, 1908:232. Holotype ♀, Paraguay, Asuncion, Anisits leg., 4-I (not located).

Taxonomy: Moure, 1947:35 (in *Epanthidium*).

The male has a bilobate tergum VII which is distinctive except for *E. boharti*. The female lacks a longitudinal carina on tergum VI which is also characteristic for *E. boharti* and *E. erythrocephalum*. The tricolor pattern of *E. paraguayense* distinguishes both sexes from *E. boharti*, whereas the non-angled axilla provides an easy recognition character from *E. erythrocephalum*. All of the previous records were from N.E. Argentina, Paraguay and S.E. Brazil so that the newly collected material from N.W. Argentina is an important range extension.

New records (33 ♂, 30 ♀).—ARGENTINA: *Salta*: Yacochuya, 9 km N.W. Cafayate, IV, Porter & Stange (29 ♂, 24 ♀—FSCA, LACM, Fritz Coll.); Pocitos, XI, Fritz (1 ♀—FSCA). *Catamarca*: El Rodeo, IV, Porter (2 ♂—FSCA). *Misiones*: Bompland, I, Joergensen (1 ♂—La Plata); Dos de Mayo, XI, Escobar & Claps (1 ♀—IML). *Tucuman*: 10 km W. Las Cejas, IV, Stange (1 ♂—FSCA). BRAZIL: Xambore, XII, Azeveda (1 ♀—Curitiba); Matto Grosso, IV–V, Fairchild (1 ♀—FSCA). PARAGUAY: Independencia, II, J. Foerster (1 ♀—KU); Rio Ypane, Cororo, II, Fritz (1 ♀—Fritz Coll.).

***Epanthidium sanguineum* (Fries)**

(Fig. 10)

Anthidium sanguineum Fries, 1908:74. Syntypes, ♂, ♀, Mendoza & Tucuman (Vienna!).

Taxonomy: Joergensen, 1912:138 (in *Dianthidium*); Moure, 1947:35 (in *Epanthidium*).

This species is distinguished easily from all other known *Epanthidium* by the nearly impunctate tegula. The apically bispined subapical ridge of sternum VI of the female is diagnostic for that sex. In the male the toothed midcoxa is characteristic. Coloration is highly variable with the metasoma reddish in terga I–II, and III–VI much darker with or without pale areas on the terga. It is fairly abundant in the Subandean desert of western Argentina.

New records (25 ♂, 24 ♀).—ARGENTINA: *Catamarca*: 8 mi. N. Belen, flowers of *Zuccagnia*, X, Stange (3 ♂, 1 ♀—FSCA); Andalgala, flowers of *Prosopis alba*, X, Willink & Stange (1 ♂—IML); 6 km S. Santa Maria, flowers of *Larrea divaricata*, XII, Willink & Stange (1 ♀—IML); Ampajango, XII, Stange (1 ♀—FSCA). *La Pampa*: Sierra Lihuel Calel, II, Stange (1 ♀—FSCA). *La Rioja*: 7 km S. Villa Casana, flowers of *L. divaricata*, XII, Porter & Stange (1 ♂, 5 ♀—FSCA); Villa Union, XII, Porter & Stange (1 ♀—FSCA). *Mendoza*: La Pasarella, flowers of *L. divaricata*, XI, Neff (1 ♂—FSCA). *Rio Negro*: Balneario Las Grutas, I, J. & L. Stange (1 ♀—FSCA). *Salta*: Yacochuya, 9 km N.W. Cafayate, XII, Porter & Stange (1 ♀—FSCA). *Tucuman*: Amaicha, XI, I, Stange (3 ♂, 2 ♀—FSCA).

***Epanthidium tigrinum* (Schrottky)**

(Fig. 14)

Hypanthidium tigrinum Schrottky, 1905:10. Holotype ♀, Paraguay, Villa Encarnacion (Vienna!).

Anthidium multifasciatum Strand, 1910:547. Syntypes, 4 ♂, Paraguay, Villa Morro and Asuncion (Berlin). **New synonymy.**

Taxonomy: Schrottky, 1908:231 (in *Dianthidium*; description of ♂); Moure, 1947:33 (type species of *Epanthidium*).

The male of this species is unique in the genus in having reddish bristles on metasomal sternum III and by the small process of the mesepisternum. The female is distinguished easily by the mostly yellow mandibles. The typical pale stripes on the mesoscutum do not vary in my specimens, but occur in some other species.

New records (14 ♂, 13 ♀).—ARGENTINA: *Misiones*: Cataratas del Iguazu, XI, C. Porter & L. Stange (13 ♂, 9 ♀—FSCA, UCD, LACM). PARAGUAY: Villa Encarnacion (2 ♀—Vienna, LACM); Villarrica, II, F. H. Schade (1 ♀—KU). BRAZIL: *Goiás*: Ihla do Bananal, Santa Isabel do Moro, VI, M. Alvarenga (KU); *Minas Gerais*: Belo Horizonte (1 ♀—Curitiba). BOLIVIA: *Santa Cruz*: Buena Vista, I, Porter & Stange (1 ♂—FSCA).

FLORAL RECORDS

All floral records are from Argentina, mostly from Andalgala, Prov. Catamarca, October 1973 to March 1974 by J. L. Neff, unless otherwise noted.

ACANTHACEAE

Justicia campestris Griseb.

BORAGINACEAE

Heliotropium sp.

CAPPARIDACEAE

Atamasquea emarginata Miers ex Hook. & Arn.

COMPOSITAE

Hyalis argentea D. Don ex Hook. & Arn.

Senecio sp.

EPANTHIDIUM spp.

confusum (1 ♂, 1 ♀, Cuesta de Chilca, Catamarca)

bicoloratum (1 ♂, Fuerte Quemada, Tucuman, I, Neff)

sanguineum (4 ♂, 3 ♀, III)

joergenseni (1 ♂, XII)

bertonii (1 ♂, Belen, Catamarca, XII, Neff)

bicoloratum (Joergensen, 1912)

Tessaria dodonaefolia Cabrera

T. absinthioides (Hook. & Arn.) DC

Wedelia glauca (Ortega) Blake

Verbesina octantha S. F. Blake

Verbesina sp.

EUPHORBIACEAE

Jatropha excisa Griseb.

LABIATAE

Salvia gilliesii Benth.

LEGUMINOSAE

Hoffmanseggia sp.

Marrubium vulgare L.

Prosopis chilensis (Mol.) Stuntz

P. nigra (Griseb.) Hieron.

P. alba Griseb.

Adesmia muricata (Jacq.) A. DC

Adesmia sp.

Zuccagnia punctata Cav.

Cercidium praecox (R. & P. Harms.)

LOASACEAE

Caliphora sp.

bertonii (1 ♂, Andalgala, X, Bohart; 1 ♂, Belen, Catamarca, XII, Neff)

bicoloratum (1 ♀)

joergenseni (1 ♂, Chaquiago, Catamarca, XII, Neff)

bicoloratum (1 ♀)

bicoloratum (6 ♂, 2 ♀, Andalgala, XI, Bohart)

joergenseni (7 ♂, 1 ♀, Andalgala, X, Stange)

sanguineum (2 ♂, XII)

bicoloratum (1 ♂)

paraguayense (1 ♂, Yacochuya, Salta, IV, Stange)

confusum (after Joergensen, 1912)

joergenseni (after Joergensen, 1912)

bicoloratum (2 ♀, Yacochuya, XII, Stange)

bertonii (2 ♀, Yacochuya, XII, Stange; 1 ♂, Salta, XII, Neff)

autumnale (1 ♀, Yacochuya, Salta, XII, Neff)

erythrocephalum (1 ♂, Yacochuya, XII, Stange)

joergenseni (2 ♂)

sanguineum (1 ♂)

bicoloratum (13 ♂, 4 ♀)

sanguineum (1 ♂, 1 ♀, Colpes, Catamarca)

bertonii (2 ♂, Carrizal, La Rioja, X, Bohart)

bicoloratum (5 ♂, 1 ♀, Andalgala, XI, Bohart)

confusum (1 ♀, Yacochuya, XII, Stange)

autumnale (1 ♂, Yacochuya, Salta, Stange)

bicoloratum (1 ♀)

bicoloratum (1 ♂)

confusum (Joergensen, 1912)

joergenseni (1 ♀, Yacochuya, Salta, XII, Stange)

nigrescens (1 ♀, Yacochuya, Salta, XII, Stange)

bertonii (1 ♀, Escoipe, Salta, II, Neff)

OXALIDAE

Oxalis sp. *confusum* (1 ♀, Agua de las Palomas, Catamarca, I, Neff)

POLYGALACEAE

Monnina lorenziana Chod. *sanguineum* (1 ♀, III)
bicoloratum (1 ♂)

SOLANACEAE

Salpichroa organifolia (Lam.) Thellung *bicoloratum* (2 ♂, 1 ♀)
Lycium chilense Miers ex Bert. *bicoloratum* (1 ♀, Los Cocos, Cordoba, I, Stange)
autumnale (1 ♂, 1 ♀, Los Cocos, Cordoba, I, Stange)

VERBENACEAE

Lippia turbinata Griseb. *bicoloratum* (7 ♂, 1 ♀)

ZYGOPHYLLACEAE

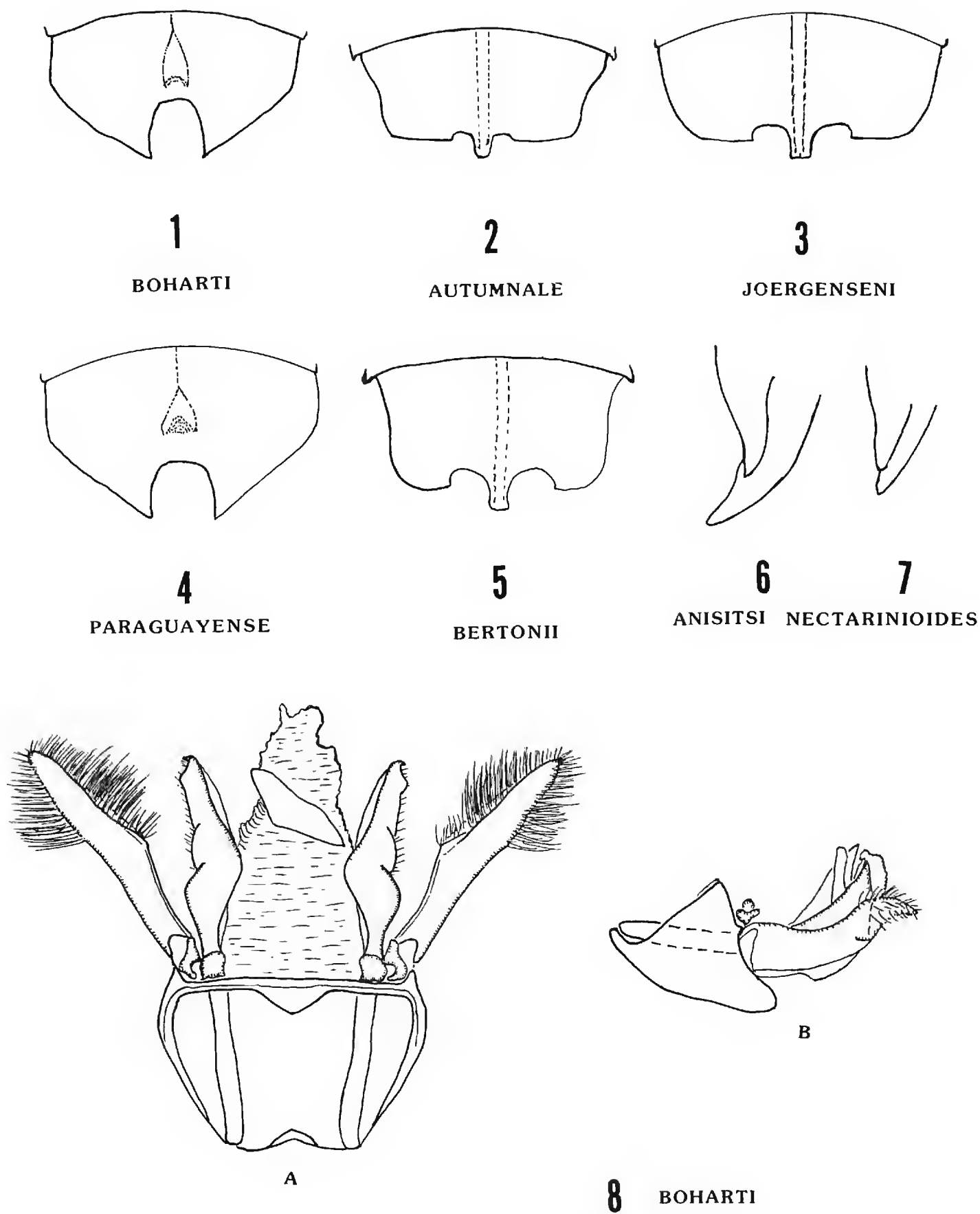
Bulnesia foliosa Griseb. *bertonii* (1 ♂, Tapia, Tucuman, II, Neff)
Larrea cuneifolia Cav. *sanguineum* (3 ♂, 3 ♀, XII)
bicoloratum (3 ♂)
sanguineum (2 ♂, XII; 1 ♂, XI, La Pasarella, Mendoza, Neff)
bicoloratum (2 ♂, Cebollar, La Rioja, XI, Bohart)
joergenseni (1 ♂, Andalgala, XI, Bohart)
bertonii (1 ♂, Andalgala, X, Bohart)

L. divaricata Cav.

KEY TO SPECIES OF *EPANTHIDIUM* MOURE

Males

- 1. Seventh metasomal tergum bilobate (Figs. 1, 4); curved ridge of sternum II ending laterally in blunt process, without associated reddish bristles; height of opaque lamella of posterior lobe of pronotum less than midocellus diameter 2
- Seventh tergum trilobate (Figs. 2, 3, 5); curved ridge of sternum II usually ending laterally in sharp tooth, sometimes with reddish bristles mesad to tooth or on sternum III; height of translucent lamella of posterior lobe of pronotum usually more than midocellus diameter (except *E. nectarinioides*) 3
- 2. Black with ivory markings on head, pronotum, axillae, metanotum, and some metasomal terga; emargination of tergum VII deeper than width at apex (Fig. 1) (Mexico) *boharti* Stange, n. sp.
- Black and yellow, with orange on vertex, metanotum, tegula and legs; emargination of tergum VII about equal to width at apex (Fig. 14) (Argentina, Brazil, Paraguay) *paraguayense* (Schrottky)
- 3. Metasomal sternum II or III with prominent, usually dark reddish bristles mesad of tooth or lateral angle 4
- Metasomal sternum II and III without bristles 6
- 4. Metasomal sternum II with only 1 or 2 prominent bristles mesad of



Figs. 1-8. *Epanthidum* spp. 1-5, Male tergum VII, dorsal view. 6, 7, Side view of tergum VII. 8, Male genitalia (a = ventral view, b = lateral view).

tooth but III with many bristles; mesepisternum with small tooth posterior to extreme ventral part of preepisternal carina; ventral median longitudinal carina of mesosoma low throughout; tegula with many fine punctures (Misiones, Argentina; Bolivia; Brazil; Paraguay) *tigrinum* (Schrottky)

- Metasomal sternum II with more prominent, usually dark red bristles mesad of tooth than on sternum III; mesepisternum without small tooth

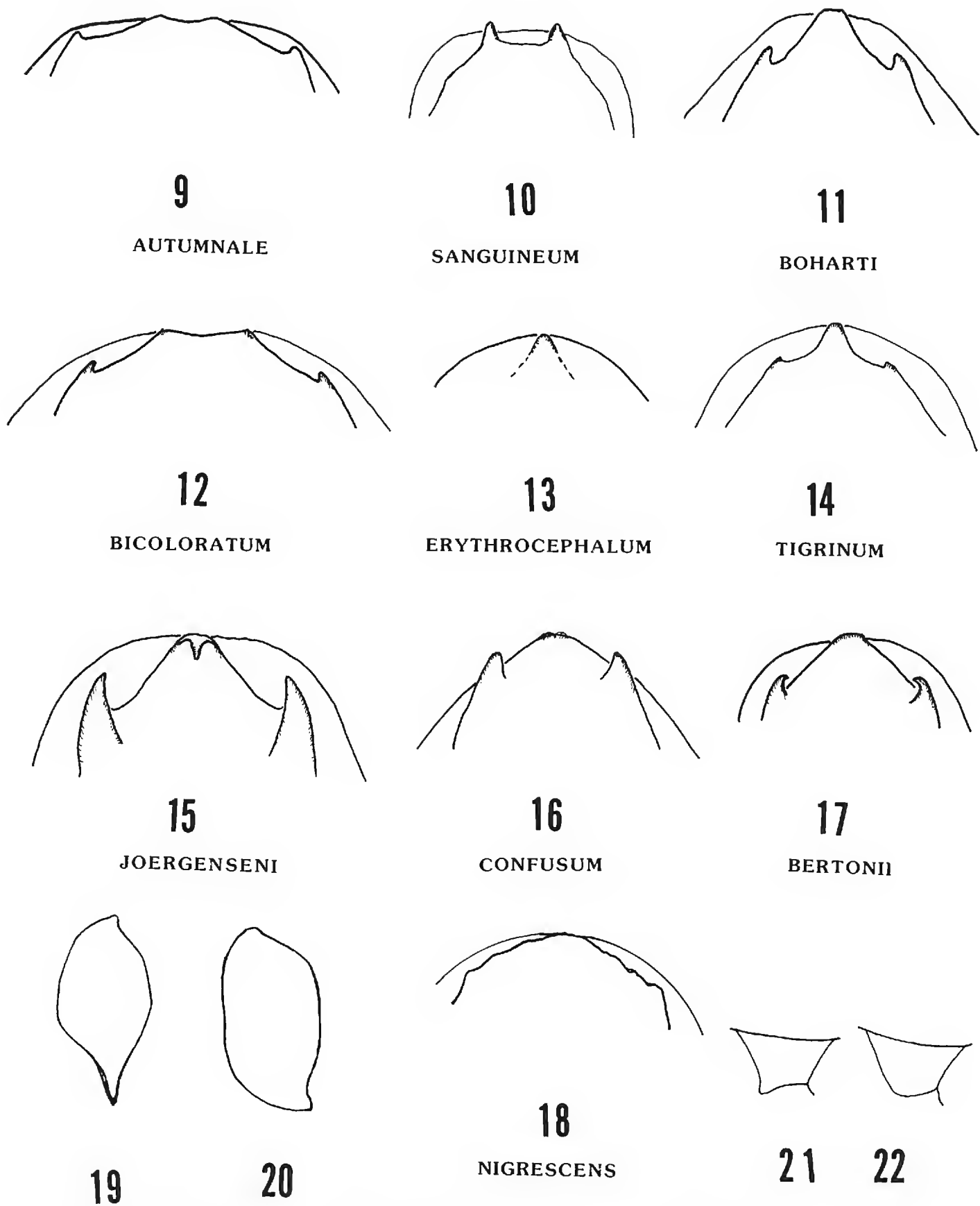
- ventrally; ventral median longitudinal carina of mesosoma produced toothlike near anterior margin, or midcoxa with tooth at mesal posterior angle; tegula punctate or nearly impunctate 5
5. Ventral median longitudinal carina of mesosoma low throughout its course; reddish bristles on sternum II running nearly to midline; tegula nearly impunctate; midcoxa produced toothlike at mesal posterior angle (Subandean desert, Argentina) *sanguineum* (Friese)
- Ventral median longitudinal carina of mesosoma produced toothlike near anterior margin; reddish bristles end well before midline; tegula with many fine punctures; midcoxa without tooth at mesal posterior angle (Subandean desert, Argentina—dark form; Chaco, Argentina; Bolivia—reddish form) *nigrescens* (Friese)
6. Tegula drawn out posteriorly and thickened dorso-ventrally (Fig. 19); midcoxa with small tooth or angle at mesal posterior angle *bicoloratum* (Smith)
- Tegula not drawn out and thickened posteriorly (Fig. 20); midcoxa without process at mesal posterior margin 7
7. Midventral carina of mesosoma produced toothlike near anterior margin (Subandean desert, Argentina) *confusum* (Smith)
- Midventral carina of mesosoma not produced toothlike 8
8. Tergum VII with lateral lobe nearly continuous with median process (Fig. 2) (Subandean desert, Chaco or Misiones, Argentina) *autumnale* (Schrottky)
- Tergum VII with deep U-shaped emargination separating lateral lobe from median process (Figs. 3, 5) 9
9. Upper row of propodeal pits strongly developed for nearly complete distance; axilla angled or metasoma with anterior terga dark and posterior terga orange 10
- Upper row of propodeal pits weakly developed, fading toward middle; axilla not angled; metasoma without contrasting dark and orange terga 11
10. Metasoma with terga I–II dark, III–VI orange; axilla not angled (Fig. 22) (N.W. Argentina, Bolivia, Brazil, Paraguay) .. *nectarinoides* (Schrottky)
- Metasoma with all terga dark with yellow spots or transverse stripes; axilla angled (Fig. 21) (N. Argentina, Bolivia, S.E. Brazil, Paraguay) .. *erythrocephalum* (Schrottky)
11. Tergum VII with middle process projecting below plane of lateral process (Fig. 6); tooth at lateral margin of transverse ridge of metasomal sternum II very large (basal width about equal to basal width of hind basitarsomere), elevated at about a 40° angle from surface (Paraguay) *anisitsi* (Schrottky)
- Tergum VII with middle process on same plane as lateral process (Fig. 7); tooth of transverse ridge of sternum II small, only slightly raised from surface 12
12. Lateral margins of terga V–VI with toothlike projections; tergum VII with width of lateral process less than 2 times that of emargination between middle and lateral processes (Fig. 5) (N. Argentina, Bolivia) *bertonii* (Schrottky)

- Lateral margins of terga V–VI tuberculate; tergum VII with width of lateral process more than 2 times that of emargination between middle and lateral process (Fig. 3) (Subandean desert, Argentina) *joergenseni* (Frieese)

Females

(Female of *E. anisitsi* unknown)

- 1. Tergum VI without longitudinal carina; mandible mostly dark; clypeus without continuous impunctate raised band along midline, although some impunctate areas may be present 2
- Tergum VI with longitudinal carina for at least half the distance between anterior margin and sting emargination, if weak or obscure (some *tigrinum* and *nigrescens*), mandible mostly yellow or clypeus with strong impunctate raised band on midline from apex to dorsal border 4
- 2. Axilla strongly angled laterally (Fig. 21); sternum VI with subapical ridge not produced into a prominent tooth sublaterally (Fig. 13); tergum VI with sublateral band produced into spine laterally followed by small series of teeth (best seen in ventral view); height of translucent lamella of pronotal lobe more than midocellus diameter (N. Argentina, Bolivia, S.E. Brazil) *erythrocephalum* (Schrottky)
- Axilla rounded laterally (Fig. 22); sternum VI with subapical ridge produced into a prominent tooth sublaterally (Fig. 11); tergum VI with lateral angle of sublateral band rounded followed by a rounded lobe; height of opaque pronotal lobe less than midocellus diameter 3
- 3. Black with ivory markings; terga III–VI with transverse ivory band at middle, black laterally; distance from lateral ocellus to posterior margin much greater than interocellar distance, area below midocellus with punctures about a puncture diameter apart (N.E. Mexico) *boharti* Stange, n. sp.
- Black and yellow, with orange on vertex, metanotum, tegula and legs; terga III–VI dark at middle with sublateral pale band; distance from lateral ocellus to posterior margin about equal to or less than interocellar distance, sculpture about the same as area below midocellus (Salta and Misiones, Argentina; S.E. Brazil; Paraguay) *paraguayense* (Schrottky)
- 4. Tegula drawn out posteriorly into a laterally compressed process (Fig. 19) (Argentina) *bicoloratum* (Smith)
- Tegula not drawn out posteriorly (Fig. 20) 5
- 5. Tegula nearly impunctate; subapical ridge of sternum VI with pair of submedium spines at posterior middle (Fig. 10) (Argentina deserts) *sanguineum* (Frieese)
- Tegula with many fine punctures; subapical ridge of sternum VI without pair of spines 6
- 6. Mandible predominately yellow; tergum VI with longitudinal carina weak, sometimes obliterated (N.E. Argentina, Bolivia, S.E. Brazil, Paraguay) *tigrinum* (Schrottky)
- Mandible predominately dark (some *bertonii* have yellowish mandibles but carina of tergum VI strongly developed) 7



Figs. 9-22. *Epanthidium* spp. 9-18, Female sternum VI in ventral view. 19, 20, dorsal view of tegula; 19, *E. bicoloratum*, 20, *E. autumnale*. 21, 22, Dorsal view of axilla; 21, *E. erythrocephalum*, 22, *E. nectarinioides*.

- 7. Body and terga I-II black, terga III-VII mostly orange (N. Argentina, S.E. Brazil) *nectarinioides* (Schrottky)
- Without this color combination, terga I-II with pale spots or transverse stripes or mostly reddish 8
- 8. Midventral carina of thorax raised abruptly at anterior margin; longitudinal carina of tergum VI abruptly raised near middle; terga I-II mostly

- reddish and terga III–V dark with large pale-yellow transverse stripes (Subandean desert, Argentina) *confusum* (Smith)
- Midventral carina of thorax not raised; longitudinal carina of tergum VI not abruptly raised near middle; different color combination on abdominal ridge 9
9. Metasomal sternum VI with subapical ridge strongly produced laterally and with a truncate (Fig. 17) or spine-like median process (Fig. 15); longitudinal carina of tergum VI strong to posterior margin 10
- Metasomal sternum VI with subapical ridge usually angled at most laterally, when somewhat produced process not much larger than lateral angle of tergum VI (Figs. 12, 18), without discrete median process; longitudinal carina of tergum VI not reaching posterior margin or weaker than impunctate raised area on clypeus 11
10. Metasomal sternum VI with subapical ridge produced spine-like at middle (Fig. 15); lateral angle of tergum V weakly developed, much smaller than lateral angle of tergum VI (Subandean desert, Argentina) *joergenseni* (Friese)
- Metasomal sternum VI with subapical ridge truncate at middle (Fig. 17); lateral angle of tergum V strongly developed, often as large as lateral angle of tergum VI *bertonii* (Schrottky)
11. Median impunctate raised band on clypeus more strongly developed than median longitudinal carina of tergum VI (which is usually strongest near posterior margin) (N.W. Argentina) *nigrescens* (Friese)
- Median impunctate raised band on clypeus less developed than median carina of tergum VI (which fades toward posterior margin) (N. Argentina, S.E. Brazil) *autumnale* (Schrottky)

LITERATURE CITED

- Friese, H. 1906. Resultate einer Reise des Herrn A. C. Jensen-Haarup in die Gegend von Mendoza (Argentina). Hymenoptera, Fam. Apidae. Flora og Fauna 3:89–102.
- . 1908. Die Apidae (Blumenwespen) von Argentina nach den Reisenergebnissen der Herren A. C. Jensen-Haarup und P. Jørgensen in den Jahren 1904–1907. Flora og Fauna (1908): 1–74.
- . 1911. Apidae. I. Megachilinae. In: F. E. Schulze, ed., Das Tierreich 28:1–440. R. Friedländer und Sohn, Berlin.
- Grigarick, A. A., and L. A. Stange. 1968. The pollen-collecting bees of the Anthidiini of California (Hymenoptera: Megachilidae). Bull. Calif. Insect Survey 9:1–113.
- Joergensen, P. 1912. Revision der Apiden der Provinz Mendoza, Republic Argentina (Hym.). Zool. Jahrb. Syst. 32:89–162.
- Michener, C. D. 1948. The generic classification of the anthidiine bees (Hymenoptera, Megachilidae). Amer. Mus. Novitates (1381):1–29.
- Michener, C. D., and E. Ordway. 1964. Some anthidiine bees from Mexico. J. New York Ent. Soc. 72:70–78.
- Moure, J. 1947. Novos agrupamentos genéricos e algumas espécies novas de abelhas sulamericanas. Mus. Paranaense Publ. Avulsas (3):1–37.
- Schrottky, C. 1903. Ensaio sobre as abelhas solitárias do Brasil. Rev. Mus. Paulista 5:330–613.
- . 1905. Contribucion al conocimiento de los Himenopteros del Paraguay. Ann. Cient. Paraguay (4):1–14.
- . 1908. Nuevos Himenópteros. Ann. Soc. Cient. Argentina 65:225–239.
- . 1909a. Hymenoptera nova. Ann. Soc. Cient. Argentina 67:209–228.
- . 1909b. Himenópteros de Catamarca. Ann. Soc. Cient. Argentina 68:233–272.

- . 1910. Neue sudamerikanischen Arten der Bienengattung *Anthidium* Fabr. Ent. Ztg. Wien 29:267-271.
- . 1920. Himenopteros nuevos o poco conocidos sudamericanos. Rev. Mus. Paulista 12:179-227.
- Smith, F. 1879. Descriptions of new species of Hymenoptera in the collection of the British Museum. Taylor and Francis, London, 240 pp.
- Strand, E. 1910. Beiträge zur Kenntnis der Hymenopterenfauna von Paraguay auf Grund der Sammlungen und Beobachtungen von Prof. J. D. Anisits. VII. Apidae. Zool. Jahrb. Syst. 29: 455-562.
- Schwarz, H. 1933. Some Neotropical Anthidiinae: *Anthidium*, *Heteranthidium*, and *Dianthidium*. Amer. Mus. Novitates (624):1-27.
- Vachal, J. 1904. Voyage de M. G. A. Baer au Tucuman (Argentine). Hymenoptera mellifera (Familia unica: Apidae). Rev. d'Ent. (France) 23:9-26.

**A Redefinition of the *Ageniella partita* Group with
Descriptions of Two New Species
(Hymenoptera: Pompilidae)**

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The *partita* group of the subgenus *Ageniella* was treated by Townes (1957). He included five species, two known from both sexes, two from the female only and one from the male only. The present paper redefines the group, excludes one previously described species and provides descriptions of two new species based on both sexes.

As far as is known, the *Ageniella partita* group is strictly Nearctic in distribution and includes species of small size and fugitive habits which are not well represented in most collections. Features which will separate this group from others in the subgenus are: Anterior wing of both sexes hyaline, neither patterned nor infusate except often with a poorly defined dark band at apex; marginal cell more than its own length from wing apex; third submarginal cell short, at least 0.65 as high as long; second recurrent vein meets third submarginal cell usually considerably beyond middle and joins subdiscoidal vein half or less distance from origin of subdiscoidal to wing margin; brush on inner side of posterior tibia somewhat narrowed but usually not interrupted toward apex; females always with mesosoma or metasoma red or orange; males of some species with tibial spurs of anterior and middle legs white.

An explanation of the abbreviations used in the following descriptions is given by Evans (1966:4). L and W refer to length and width, respectively and A3 refers to the third antennal segment.

For the loan of comparative material, I wish to thank A. S. Menke, Systematic Entomology Laboratory, U.S.D.A., % United States National Museum, Washington, D.C. (USNM), A. Newton, Museum of Comparative Zoology, Harvard University, Cambridge (MCZ), W. J. Pulawski, California Academy of Sciences, San Francisco (CAS) and R. O. Schuster, University of California, Davis (UCD).

***Ageniella (Ageniella) joannae* Wasbauer, NEW SPECIES**
(Figs. 1, 2)

Holotype female. — 5.4 mm. Anterior wing 4.10 mm. Integumental color of head black, of lower face, clypeus, antennae, legs, mesosoma and metasoma medium brown, the following areas suffused with black: mesonotum laterally and posteriorly, scutellum laterally, postscutellum medially, base of petiole and tarsi. Appressed pubescence long, dense, pale golden, somewhat coarser at apices of T 2-4, forming ill-defined apical bands, silvery on mesepisternum, propodeum and posterior coxae dorsally. Erect hairs short, pale golden, scattered over entire body, longer on vertex, clypeus, mandibles, prosternum laterally, pygidium and metasomal sterna. Head rounded, slightly broader than long, TFD/FD 1.01; MID/FD

0.55; ocelli in a compact, somewhat acute triangle, laterals much nearer to compound eyes than to each other, POL/OOL 0.64. Length of clypeus $0.40 \times$ width, frontal surface gently convex, apical margin slightly convex with ill defined prominence medially, apical hairless portion shining, wider at middle, set off from remainder of clypeus by a distinct narrow groove. Antennae of moderate length, WA3/LA3 0.28, LA3/UID 0.73. Length of anterior wing marginal cell $0.86 \times$ distance from its apex to apex of wing. Transverse median vein meeting media at origin of basal. Second recurrent vein nearly straight posteriorly, but strongly curved at anterior fourth, meeting third submarginal cell $0.75 \times$ distance from base to apex of cell.

Allotype male.—5.07 mm. Anterior wing 3.13 mm. Integumental color of head black, that of lower face, clypeus, mandibles, mesosoma and anterior segments of metasoma, light orange-brown, the following areas suffused with black: antennae, palpi, mesonotum and scutellum laterally, postscutellum medially, mesepisternum ventrally, tarsi, base of petiole and apical metasomal segments. Tibial spurs of anterior legs orange-brown, suffused with black at apices, spurs of middle and posterior legs black. Appressed pubescence pale, coarse, silvery on lower face, occiput, prosternum, mesepisternum, posterior face of propodeum, and posterior coxae dorsally. Head rounded, no broader than long, TFD/FD 1.00. Compound eyes slightly divergent dorsally, UID/LID 1.15. Ocelli in a slightly acute triangle, nearer each other than to compound eyes, POL/OOL 0.67. Antennae moderately long, WA3/LA3 0.42, LA3/UID 0.60, width of penultimate segment $0.41 \times$ length. Subgenital plate gradually tapering to a narrowly rounded apex, strongly convex in cross section but without a basal, triangular, flat-topped area. Genitalia (Fig. 1) with ventral lobe of digitus nearly horizontal, exceeding dorsal lobe; dorsal lobe nearly vertical, blade-like. Aedeagus parallel-sided, not expanded at apex. Gonostylus in lateral view (Fig. 2) with dorsal margin strongly sinuate.

Types.—Holotype ♀ (UCD): CALIFORNIA: *San Diego Co.*: Warner Springs, Aqua Caliente Creek, elevation 3100', VIII-23/25, 1980 (J. Slansky). Allotype ♂ (UCD) and paratypes (9 ♀, 11 ♂, CAS and author's collection) with same data as holotype except collectors P. Adams, M. Wasbauer. Some specimens were taken in a Malaise Trap.

The collector informs me that the holotype was taken as it walked among foraging ant workers and was difficult to distinguish from the ants because of similar size, coloration and pilosity. The ant was subsequently determined as *Formica pilicornis* Emery.

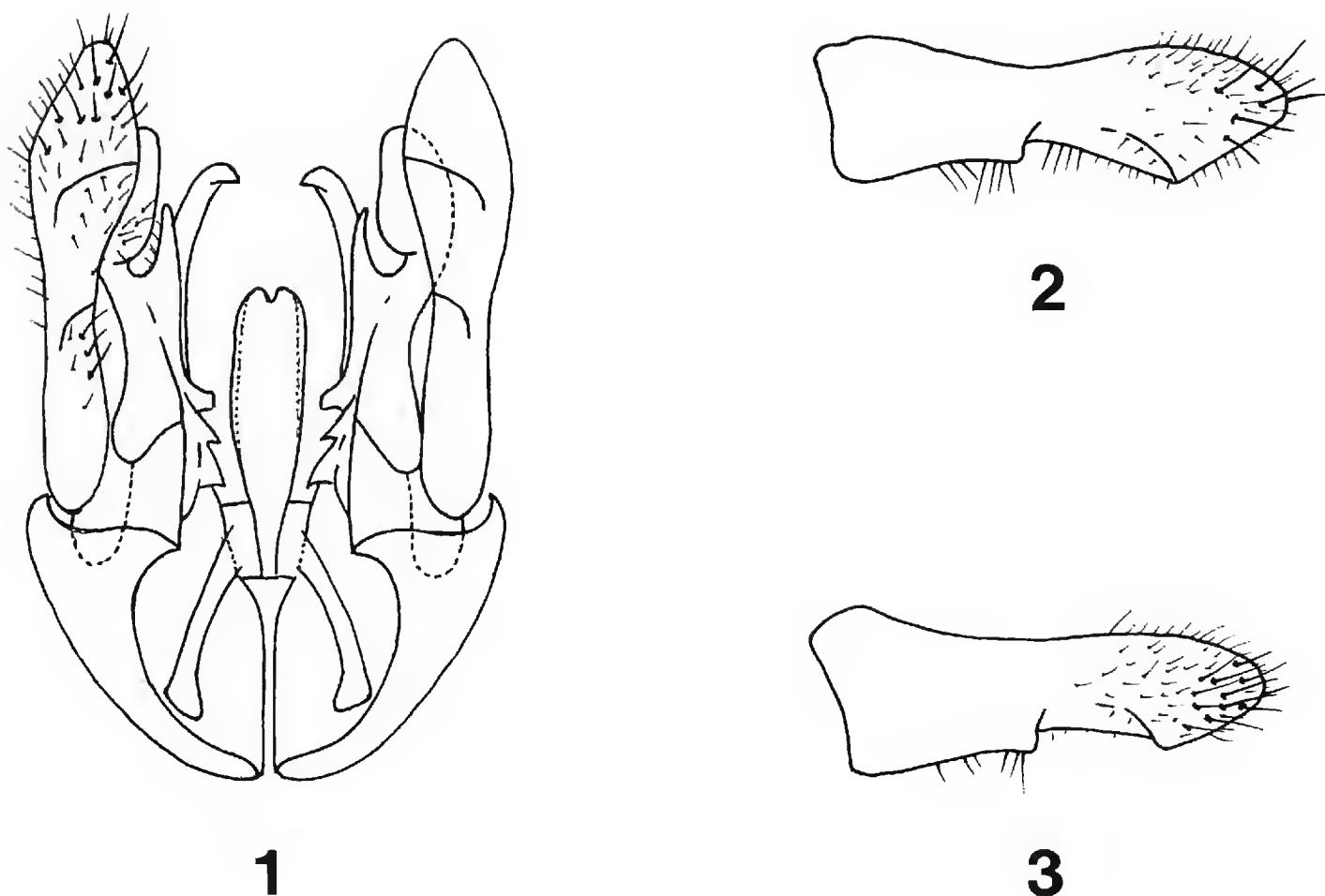
This species is affectionately dedicated to Joanne Slansky.

A discussion of the relationships of *Ageniella joannae* is given together with that for *A. boharti*.

***Ageniella (Ageniella) boharti* Wasbauer, NEW SPECIES**

(Fig. 3)

Holotype female.—4.4 mm. Anterior wing 3.70 mm. Integumental color of head and mesosoma, antennae, palpi and legs light orange-brown, posterior tarsi a little darker; metasoma dark brown, nearly black. Appressed pubescence very sparse, pale golden becoming silvery on mesepisternum anteriorly and posterior coxae dorsally. Erect hairs pale golden, very short and scattered except for a few longer hairs on vertex, clypeus, mandibles, pygidium and metasomal sterna. Head slightly



Figs. 1, 2. *Ageniella joannae*. 1, Male genitalia, ventral view. Vestiture omitted on right side. 2, Left gonostylus, external view. Fig. 3. *Ageniella boharti*. Left gonostylus, external view.

longer than broad, TFD/FD 0.97, MID/FD 0.63. Ocellar bases darkened, ocelli in a compact triangle, the laterals much nearer each other than to compound eyes, POL/OOL 0.71. Length of clypeus $0.37 \times$ width, frontal surface gently convex, apical margin nearly straight, hairless portion of apex shining, set off from remainder of clypeus by an indistinct groove. Antennae relatively short, WA3/LA3 0.30, LA3/UID 0.56. Length of anterior wing marginal cell $0.60 \times$ distance from its apex to apex of wing. Transverse median vein meeting media at origin of basal. Second recurrent vein strongly curved, meeting third submarginal cell $0.65 \times$ distance from base to apex of cell.

Allotype male.—2.21 mm. Anterior wing 1.59 mm. Integumental color of head and metasoma black; mesosoma, clypeus, lower face, scape and pedicel pale orange-brown; antennal flagellum and tarsi dark brown, the following areas of mesosoma suffused with black: mesonotum, scutellum, postscutellum and mesepisternum anteriorly. Tibial spurs of anterior and middle legs pale yellowish white, of posterior legs blackish. Appressed pubescence sparse, pale over entire body, coarser, silvery on lower face, clypeus, occiput, and most of mesosoma. Head rounded, slightly broader than long, TFD/FD 1.05. Compound eyes divergent dorsally, UID/LID 1.28. Ocelli in a compact, slightly acute triangle, nearer each other than to compound eyes, POL/OOL 0.70; antennae moderately long, WA3/LA3 0.40, LA3/UID 0.45, penultimate segment 0.55 as wide as long. Subgenital plate narrow, tapering gradually from base to a narrowly rounded apex; strongly convex but without a basal, triangular, flat-topped area. Genitalia as in *Ageniella joannae* but gonostylus in lateral view (Fig. 3) with dorsal margin not as strongly sinuate.

Types.—Holotype ♀ (UCD): CALIFORNIA: *San Diego Co.*: Borrego Valley, IV-11-1969, R. M. Bohart collector. Allotype ♂ (UCD) and paratypes (5 ♀, 2 ♂, CAS and author's collection): CALIFORNIA: *San Diego Co.*: Borrego State Park, Clark Dry Lake, III-31 and IV-1, 1977, M. Wasbauer, J. Slansky, collectors.

At Clark Dry Lake, both sexes frequented the margins of the lake where there were numerous cracks in the dried mud surface. Females were found investigating the cracks and possibly were using them for nesting.

This species is named for a long time friend and associate, Prof. R. M. Bohart, in honor of his outstanding contributions to our knowledge of the biology and taxonomy of aculeate wasps.

Ageniella pallida Banks, known from females only, was placed by Townes (1957) in the *A. partita* group. It is a species with an orange mesosoma and in this regard is similar to *Ageniella joannae* and *A. boharti*. I have examined the holotype of *pallida* in the MCZ and other material in the USNM. The following features will separate it from *A. joannae* and *A. boharti* and exclude it from the *partita* group as here defined: Anterior wing marginal cell long, $0.85-0.89 \times$ its length from wing apex; third submarginal cell long, height $0.54-0.55$ length; second recurrent vein meets third submarginal cell before middle and intersects subdiscoidal vein more than half distance from origin of subdiscoidal to wing margin.

With *A. pallida* excluded, the only members of the *partita* group with orange or brown mesosoma are *Ageniella joannae* and *A. boharti*. These species differ as follows: for females, the body of *Ageniella joannae* is uniformly light brown and exhibits a rather conspicuous pale golden appressed pubescence. The body of *A. boharti* is noticeably bicolored with the mesosoma light brown and the metasoma nearly black, with the appressed pubescence very dilute and much less conspicuous. The ratio MID/TFD averages 0.61 for *A. joannae* and 0.58 for *A. boharti*. LA3/UID averages 0.71 for *A. joannae* and 0.59 for *A. boharti*. There is no overlap in the ranges of these two ratios for the type series of either species. For males, *A. joannae* and *A. boharti* are similarly colored but the first two metasomal segments of *A. joannae* are concolorous with the mesosoma and the middle tibial spurs are dark. In *A. boharti*, the metasoma is entirely dark and the middle tibial spurs are whitish. The genitalia are very similar but the dorsal margin of the gonostylus is more strongly sinuate in *A. joannae* (Fig. 2) than in *A. boharti* (Fig. 3).

LITERATURE CITED

- Evans, H. E. 1966. A revision of the Mexican and Central American spider wasps of the subfamily Pompilinae (Hymenoptera: Pompilidae). Mem. Amer. Ent. Soc. 20:1-442.
- Townes, H. 1957. Nearctic wasps of the subfamilies Pepsinae and Ceropalinae. U.S. Natl. Mus. Bull. 209:1-286.

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This issue constitutes the whole volume for 1983. Parts 3 and 4 of Volume 58 for the year 1982 will be published later this year. This unfortunate circumstance could not be avoided.

PAUL ARNAUD, *Editor*

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